NASA Technical Memorandum 72866

AIFTDS STAND-ALONE RMDU FLIGHT TEST REPORT

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TABLE OF CONTENTS

5.0 APPENDIX

1. Description of RMDU modules used in flight test.

2. Dryden's sampling format for use in flight test.

3. Data Summary:

   3a. TM stripchart data, ground station hard copy data, and manually recorded data for PT1 → PT4.

   3b. TM stripchart data, ground station hard copy data, and manually recorded data for PT1 → PT4.

   3c. Internal precision voltage response for gains of 100 and 1000; stripchart and hard copy data.

   3d. Strip chart data and hard copy data for CPT 1 → CPT 4 showing shielding, excitation, and filter responses.

1.0 INTRODUCTION

The Airborne Integrated Flight Test Data System (AIFTDS) developed by NASA Dryden through contracts NAS4-1848 and NAS4-2161 has been subjected to two analytical studies in the past two years. The first study was designed to indicate the accuracy and operational characteristics in a hostile laboratory environment and was concluded with the publication of NASA TMX-56043. This report covers work, which commenced in mid-1976 and concluded with the last flight in July, 1977, and was designed to identify the AIFTDS performance characteristics in an actual flight environment.

1.1 Background on AIFTDS Stand-Alone Flight Test

Several documents and articles, published by both NASA and private industry, discuss the AIFTDS concept in its entirety; however, no document exists to date which analyzes the AIFTDS in a flight environment. NASA Dryden does not routinely evaluate electronic data acquisition systems in a flight environment; however, it was judged appropriate to do so for the AIFTDS. The reasoning for the decision was two-fold: first, the AIFTDS is an extremely complex, but flexible, pulse code modulation (PCM) system which requires considerable user familiarity for effective application. Second, it was deemed necessary to provide a baseline for future reference when the AIFTDS is in widespread use at Dryden Flight Research Center.

In conjunction with the two reasons stated above were the objectives of the flight test:

a. To familiarize the Dryden crew with the AIFTDS hardware and operation characteristics.

b. To study the accuracy and resolution of the system in a flight environment.

c. To determine shielding and instrumentation techniques for a system as sensitive as AIFTDS.

d. To obtain hard-copy PCM data from the flights through the Center's data reduction system.

Dryden's Measurement Engineering Branch proceeded with the flight test of the AIFTDS in 1976.

1.2 Discussion of Flight Test Plan

Because the AIFTDS is, as the name implies, a PCM data acquisition system, a flight test plan was formulated which divided the task into two phases. One phase was the flight test of the stand-alone remote multiplexer/digitizer unit (RMDU), while the second phase will be the flight test of the RMDU in conjunction with an airborne computer, an RMDU Controller Unit (RCU), and a Cockpit Control/Display Unit (CCDU), see Figure 1. This report covers only the first phase.

The knowledge gained through the first phase of the flight test will be applied directly to the as yet uncompleted second phase; e.g., optimum RMDU wiring configurations as well as sensor instrumentation developed in phase one are extremely important in the configuration control of the second phase of the flight test.

2.0 BACKGROUND ON AIFTDS

2.1 Background on the Dryden Stand-Alone Remote Multipler/Digitizer Unit (RMDU)

NASA Dryden's stand-alone configured RMDU used in the flight test program utilized the following plug in modules and/or cards: analog multiplexer (AMX) cards, presample filter/amplifier (PSF) card, excitation/bridge completion (EBC) card, analog data processor module (ADP-M), and the stand-alone timing module (SAT-M) see Figures 2a through 2e. A brief description of each is presented in Appendix 1.

2.2 Symbols and Abbreviations List

ADP-M	Analog Data Processor Module
AIFTDS	Airborne Integrated Flight Test Data System
ALT	Approach and Landing Test
AMX	Analog Multiplexer
AC.1 - AC.4	Accelerometer #1 - Accelerometer #4
BiØ-L	Bi-phase Level
BiØ-M	Bi-phase Mark
CPT 1 - CPT 4	Control Position Transducer #1 - Control Position Transducer #4
DC	Direct Current
DM-M	Delay Modulation Mark
EBC	Excitation/Bridge Completion
EPROM	Eraseable Programmable Read Only Memory
GPA-Ø	Gain Programmable Amplifier's Zero Input Response
HLC	High Level Calibration

ILT/Premod Filter	Isolation Line Terminator/Premodulation Filter Unit
ips	Inches per second
IRIG	Inter Range Instrumentation Group
LFC	Laminar Flow Control
LLC	Low Level Calibration
LSB	Least Significant Bit
MSB	Most Significant Bit
MSBLS	Microwave Scanning Beam Landing System
NRZ-L	Non-Return to Zero Level
NRZ-M	Non-Return to Zero Mark
PCM	Pulse Code Modulation
PSB	Power Supply Bite (Built In Test Equipment)
PSF	Presample,Amplifier Filter
PT1 - PT4	Pressure Transducer #1 - Pressure Transder #4
RCU	RMDU Controller Unit
RMDU	Remote Multiplxer/Digitizer Unit
SAT-M	Stand-Alone Timing Module
TC	Thermocouple
TM	Telemetry
W.O.L.	Wallace O. Leonard

2.3 Flight Test Background

Normally, a flight test program of this scope would require a period of from 6 months to a year to accomplish. The flight testing of Dryden's stand-alone system took approximately 19 months of which 9 months were actually devoted to flights. Several factors contributed to this time lag:

a. The Center viewed the AIFTDS as a low priority project.

b. The parameters originally requested had been wired in the aircraft (aircraft used was a modified Lockheed Jetstar - see Figure 3) circa 1970, and proved to be highly unreliable due to shielding and connector problems.

c. Project engineer and project instrumentation engineer were changed during the tests.

d. Higher priority programs (MSBLS, LFC, etc.) instituted after the start of the AIFTDS flight test program severely impacted the work schedule.

e. Time onboard the aircraft was restricted because of reason #4: "wringing out" or verification of the existing system was virtually impossible as was the opportunity to install new sensors in the aircraft.

f. Software was not available to analyze data on ground station.

The original parameter list agreed upon by the AIFTDS project engineer in 1975 included the following parameters, for which wiring was reported to be installed on the aircraft:

<u>Early Jetstar Parameter List</u>

Control Position Transducers: (Hi-Level Outputs)

(1) Throttle Position

(2) Rudder Pedal Position

(3) Rudder Position

(4) Aileron Position

(5) Elevator Position

(6&7) Stabilizer Position

(8) Alpha - Vane

(9) Beta - Vane

Nose Boom

Accelerometers:

(10) Lateral CG Acceleration

(11) Longitudinal CG Acceleration

(12) Right Hand Horizontal Stabilizer Root Leading Edge Vertical Acceleration.

(13) Right Hand Horizontal Stabilizer Root Trailing Edge Vertical Acceleration.

(14-17) Tail Accelerometers #1, #3, #4, #5 - Hi-Level Output

(18&19) Tail accelerometers #6, #7 - Low Level Output

Pressure:

(20) Air Speed Coarse
(21) Air Speed Fine
} 0 – 750 PSFA W.O.L.

(22) Altitude Coarse
(23) Altitude Fine
} 0 – 2200 PSFA W.O.L.

(24) Rudder Pedal Force

(25) Rudder Differential Pressure

(26) Aileron Wheel Force

(27) Total Reference Pressure

(28) Elevator Differential Pressure

Gyros:

(29) Roll Rate

(30) Yaw Rate

Presicison Voltages:

(31-42) Precision Voltages from Divider Box.

A pacer flight to calibrate the Jetstar's airspeed indicators with a calibrated craft was scheduled for June 3, 1976. This flight revealed that only 4 sensors of the 30 requested were operating. Six weeks later on July 14, another flight was flown. By this time 9 of the original 42 parameters had been installed and checked out. Two days later on July 16, another checkout flight was made; 8 sensors were operational, 14 precision voltages were employed, and 17 of the disabled sensor channels were shorted at the pallet. This flight was the first flight in which data was directed through the ground station. It then became painfully obvious that an excessive amount of time would be needed to insure the correct installation of the original sensors which were requested.

3.0 STAND-ALONE FLIGHT TEST

3.1 The AIFTDS Experimental Sensor Box Concept

It was also during this time frame (May-July 1976) when the Approach and Landing Testing (ALT - for the Shuttle program) was beginning to become active. The Jetstar was chosen as the test bed for the ALT Microwave Scanning Beam Landing System (MSBLS) as well as the facility for the Laminar Flow Control (LFC) project. The AIFTDS project had the lowest priority and hence, very little work was carried out on the Jetstar to satisfy the sensor configuration requirements.

It was at this time when the AIFTDS project leader decided to abandon the original idea of using the ship's sensors for the flight test phase. A plan was formulated which would benefit the project in two ways:

a. Trade time in the lab for actual time on the aircraft for wiring and testing of the system.

b. Would give the AIFTDS project leader complete control over sensor wiring configurations and shielding and excitation designs.

A sensor housing box was designed and constructed (See Figure 4) which was mounted inside the aircraft and fulfilled the original requirements of the AIFTDS flight test phase. In this box was a selection of commonly used sensors; i.e., strain gages, thermocouples, control position transducers (CPT's), accelerometers, and resistors. Four similar strain gages, four similar accelerometers, and four similar CPT's, as well as two similar TC's and two similar resistors were chosen. For the strain gages, accelerometers, and CPT's, there were four different methods of installation as follows:

(1) Sensor excited by an integrated signal conditioning card, and having the shield referenced or driven at the sensor end.

(2) Sensor excited by integrated signal conditioning and grounding the shield at the RMDU.

(3) Sensor excited by DFRC "standard" external signal conditioning boxes, and having the shield referenced at the sensor end.

(4) Sensor excited externally with the shield grounded at the RMDU.

For the thermocouples and the resistors the configurations were limited to shield referencing either at the sensor end or at the RMDU end (see Figures 5 and 6). With the design and construction of this sensor box, the priority/time conflict on the Jetstar and configuration control problems were resolved. On the final two flights (June-July 1977) an active pre-sample filter was employed with four of the sixteen sensors. The results from the filtered data was compared with the unfiltered responses of previous flights.

3.2 Jetstar Flight Schedules

As mentioned previously, several higher priority projects began using the aircraft originally chosen for the AIFTDS. Such additional projects, Microwave Scanning Beam Landing System (MSBLS) - part of the Shuttle Approach and Landing Tests, the Laminar Flow Control project and others, created an added burden on the flight scheduling. The MSBLS project needed a large number of flights to effectively checkout the landing system - sometimes multiple flights per day. This, of course, meant that any AIFTDS work on the aircraft had to be completed between pre-flight checks. This constraint also dictated the flight plan for the AIFTDS project when both AIFTDS and MSBLS were flown together. The Laminar Flow Control Experiment (LFC) required lengthy flights (> 90 minutes) to achieve its purpose.

The length of the LFC flights created two major problems: extending the use of the onboard tape recorder for the entire flight, and causing telemetry link dropouts by the extreme range involved. An additional problem of scheduling these flights was the time sharing of the instrumentation pallet for the multiple projects, the tape recorder and transmitter. Cooperation between the various projects was a must in order to satisfy both data requirements.

During the peak months of activity on the Jetstar as many as 4 or 5 flights were being scheduled weekly - any last minute cancellation or alteration of the flight schedule or plan would require additional manpower support from the telemetry ground station. Conflicts with the TM ground station coverage due to these cancellations or alterations often acted to eliminate the telemetry down link coverage of the AIFTDS PCM data. This, in effect, resulted in poor data visibility since no data could be verified until the ground station could play back the airborne record tape at a later date. Nonetheless, with all of these flight scheduling proglems, the AIFTDS project received the requested six data flights in a 9 month period.

3.3 Discussion of AIFTDS Data Acquisition Procedure and Equipment

A block diagram of the AIFTDS data acquisition system utilizing the AIFTDS Experimental Sensor Box as sensor input, is shown in Figure 7. A photograph of the instrumentation pallet is shown in Figure 8.

The AIFTDS Experimental Sensor Box schematic and photograph is shown in Figures 4, 5, and 6. From the schematic it can be seen that sensors PT3, PT4, AC.3, AC.4, CPT3, and CPT4 have their power derived from the pallet external signal conditioning unit. It can also be seen that sensors PT1, PT2, AC.1, AC.2, CPT.1, and CPT.2 obtain power through either the RMDU internal signal conditioning card (EBC card) or through the RMDU power supply itself. All sensors in the AIFTDS Experimental Sensor Box, however, receive their stimuli from the box itself; each individual group of sensors is exposed to identical stimuli. This factor, in conjunction with the fact that the individual group of sensors are identical allows the investigator to accurately compare data responses for the four excitation and shielding combinations.

The responses from the 16 sensors in the AIFTDS Experimental Sensor Box along with some internal RMDU "health check" signals (LLC for gains of 1000, 400, 100; HLC, GPA-Ø for gains of 400, 10; and PSB) and some shorted channels were processed and digitized by the RMDU. The RMDU has the capability of simultaneously generating two serial PCM bit streams in different codes for routing to different post-processing media. The output coding formats available are: NRZ-L, M; BiØ_L,M; and DM-M. The output data stream being sent to the onboard tape recorder is in the format of DM-M (for improved low frequency response and minimum DC base line drift) while the data stream being sent to the transmitter is in NRZ-L format. The use of these two formats is standard at NASA Dryden.

The DM-M formatted PCM data stream is recorded on the Model AR-700 airborne tape recorder in the direct mode. The NRZ-L formatted PCM data stream sent to the transmitter is first directed to a premodulation filter having a cutoff frequency of 160 Kbits/sec. The filtered output is then used to frequency modulate the telemetry transmitter carrier of 1521.5 MHz. See Figures 9 and 10 for the circuit schematic and connector configuration, and the photograph in Figure 11 for a detailed view of the filter box.

A crucial part of the AIFTDS flight test was the use of the onboard flight test engineer. The flight test engineer recorded flight data by hand through the use of the flight line tester which was mounted on the instrumentation pallet. The flight line tester, being a portable PCM decommutator, allowed the flight test engineer to record data from any of the parameters during the flight to be compared with the data processed on the ground station.

3.3.1 Real Time Processing of PCM Data

The 1521.5 MHz telemetry signal is received at the Dryden telemetry ground station. For the AIFTDS flights the PCM stream was received by the series 410 receivers and then processed by the decommutation equipment. The decommutation equipment (consisting of EMR Model 720 PCM bit synchronizer, Model 2731 PCM frame synchronizer, and Model 2736 PCM subframe synchronizer) is programmed and controlled by the SEL (Systems Engineering Laboratory) Model 86 and 810B computers.

Through this interaction between the SEL computer and the decommutation equipment, certain parameters were selected for real time display. The real time display was 32 tracks of stripchart recording in the high range ground station control room. In addition to the 32 displayed parameters, the IRIG timing track from the ground station was also displayed. IRIG-B time code generators are used to establish time correlation between real time data and that data which is recorded on the onboard tape recorder. Because of computer input/output limitations the stripchart outputs represent samples at a maximum rate of 5ms/sample (200 samples/Sec - which is the rate of the PCM system currently in use at Dryden).

3.3.2 Telemetry Dropouts

Even with directional tracking antennas the maximum range attainable with approximately 5 watts of power at 1521 MHz into the blade transmitting antenna on the aircraft is 200-300 miles (320 Km-480 Km) taking into account propogation and the aircraft's altitude. Anything between the aircraft and the receiving antenna (over the horizon, mountains, buildings, etc) severely limits this maximum range. In fact, the only reliable reception is limited to line of sight ranges. Any distance greater than this or any obstacles between the aircraft and the receiving antenna can (and usually will) cause telemetry dropout. TM dropouts can cause the PCM decommutation equipment to lose synchronization and, hence, cause "noise" to appear at the output and on the stripcharts.

If the TM dropouts are of short duration the effect is transient irregularities on the stripchart outputs. These irregularities caused by TM dropouts interfere with the monitoring of the real time processed PCM data (in that the unadulterated data looks similar to that data which is contaminate by transient type noise). To examine the TM data during the times when dropouts occur is impossible and requires the onboard tape to be played back later to fill in data for dropout times.

The instrumentation pallet (which holds the entire data acquisition system for the project - see Figure 8) was shared with other ongoing experiments at this time (MSBLS, LFC, and others). During those portions of the flight when data was to be collected for the other project(s) the AIFTDS PCM bit stream was disconnected from the transmitter's modulation input. This effected a TM dropout, also which could extend for long periods of time. However, the onboard tape recorder was used for the collection of data during this time.

In the section of this report dealing with the analysis of the flight data, many dropouts are indicated by simultaneous loss of data on all channels (see appendix).

3.3.3 PCM On Board Recording

Onboard recording of the PCM data was accomplished using an airborne AR-700 Model tape recorder. On all AIFTDS flights the tape speed was 15 ips (250 KHz bandwidth) thus giving approximately 90 minutes of recording time. The coding of the PCM data for the tape recorder was in DM-M (Delay Modulation-Mark), as well as NRZ-L (non-return to zero level), and the recorder was operated in the "direct" record mode. The bit packing density of the tape did not exceed 12,000 bits/inch throughout the flight test.

The AR-700 is a 14 track recorder (when using 1 inch width tape); AIFTDS data (NRZ-L and DM-M formats) was recorded serially on two tracks. The IRIG-B time code generator signal was recorded on another track, with the remaining eleven tracks being devoted to functions relating to the other projects which were sharing the pallet.

The tapes from the onboard recorder were held until time was available for post flight processing. The time delay was governed by the ongoing progress towards developing the software package necessary to process the flight data and the work load in the telemetry facility at Dryden. The plan of attack for processing the flight data was as follows: The data which was manually recorded (via the onboard AIFTDS flight test engineer) was correlated with the real time strip chart data. The IRIG-B time was noted for any data of interest and that time was used for selecting that portion of the flight data tape for processing through the ground station computer. See Appendix 3 for samples of data reduction in this manner.

4.0 SUMMARY AND DISCUSSIONS

4.1 Flight Objectives and Achievements

A measure of a flight test project success is to compare the results with the goals and determine if the achieved results satisfied these goals. Recalling the goals from Section 1, each will be compared with the associated results.

4.1.1 Goal #1: Familiarize the Dryden Crew with the AIFTDS Hardware and Operational Characteristics

Throughout the flight test phase of the Stand-alone AIFTDS numberous people came into intimate contact with the AIFTDS.

a. The instrumentation crew involved with the wiring and checking out of the AIFTDS installation.

b. The personnel in the telemetry ground station responsible for the decommutation and processing of the real time data from the PCM telemetry link.

c. The project engineers and the project managers involved with the overall planning and direction of the project.

d. The persons involved with procurement and contract management were all involved with and familiarized with the AIFTDS hardware and/or the operational characteristics.

Although this goal was easily achieved, it would obviously be more effective if more people could have been trained and familiarized. However, not until the AIFTDS is in widespread use at the Center as its primary data acquisition system will all of the appropriate persons be familiarized with the AIFTDS system.

4.1.2 Goal #2: To Determine Shielding and Instrumentation Techniques

As was previously stated, the Dryden RMDU possesses a resolution of 12 bits; at a gain of 1000 each count represents 5 μ volts which is six times more sensitive than the existing systems presently in use at DFRC. In order to utilize this extreme sensitivity extra care must be exercised in the sensor wiring. It was shown early in the flight test program that the existing wiring and instrumentation (excitation and signal conditioning) of the Jetstar sensors was not adequate to make full use of this increased capability. Millivolt level noise (common mode and differential mode) destroys data validity when microvolt level measurements are desired.

The experimental sensor box data clearly demonstrates the trade-offs between excitation, signal conditioning, and shielding schemes (see Appendix 3). The best overall configuration of the sensors was to ground the shield at the sensor (to minimize common mode effects) and to utilize internal signal conditioning/excitation. This fact should not be too surprising to instrumentation engineers, however, the data from the flight test demonstrates this fact beyond any shadow of doubt.

In the process of determining the appropriate shielding and excitation techniques to use, care was exercised in not eliminating noise through the use of pre-sample filtering. This method of "cleaning up" the data can give false data in the area of shielding techniques. The AIFTDS was designed with increased flexibility so that pre-sample filtering is not needed in all cases. The need for filtering can sometimes be eliminated by increasing the sample rate. However, in cases where it is not possible or feasible to increase the sample rate (due to ground station limitations, tape recorder limitations, or any other reasons) the AIFTDS does have provisions for internal active-presample filter modules. As noted earlier in this report the presample filter used in the Dryden program was programmed for a gain of 400 on 3 of the 4 channels and a gain of 1 on one channel. The filters in all 4 cases were 4-pole Butterworth low pass filters having a cutoff frequency of 50 Hz. This presample filter module was used on a select few parameters during the last 2 flights; comparison between filtered data and non-filtered data is made in the Appendix section.

4.1.3 Goal #3: To Obtain Hard Copy PCM Flight Data Through the Ground Station Facility

This goal was one of the most difficult to achieve; it certainly required the most time of all to achieve. The The Dryden PCM processing system is a complex system consisting of two SEL 32 bit computers controlling the PCM decommutators, with an SEL 86 (central processing system, a Control Data Corp. Cyber Model 7328 control computer facility, as well as many software operating systems. This processing system, being large and complex, is very difficult to change or modify. Since the AIFTDS PCM format was different for this test phase from the systems currently in use at Dryden, a modification to the presen Dryden PCM processing scheme was necessary in order to process AIFTDS data. Of course, the modifications and additions to the processing system required programming manpower; with the onslaught of the Shuttle ALT program, as well as higher priority projects at the Center very little manpower was available to work on AIFTDS requirements. Consequently, the hard copy data was received from the ground station 6 months after the last flight.

Normally, a flight project request for data processing requires pre and post-flight calibration data in order to perform the polynomial fit to the data as well as to convert the data to engineering units. The data processing also usually involves data compression by the computer controlled decommutators in the ground station. However, the requirements for the AIFTDS PCM data processing were extremely rudimentary, e.g., the only desired output from the processing was a straight decimal conversion of the raw offset binary data. In addition to the binary to decimal conversion, the display of stripchart data correlated with the IRIG-B time and the word frame and/or subframe number was requested. Data compression or engineering conversions were not performed on this data, however the gain tag bit conversion was accomplished (the gain tag bit has been discussed earlier) when converting the offset binary data to decimal value.

Because of the minimal requests for PCM data processing levied on the data reduction personnel, all the requested functional capabilities were provided in the telemetry ground station facility. This completely eliminated the need for Cyber system software and operational manpower. The PCM hard copy data was handled in a manner similar to that of the real-time strip chart outputs. The front end telemetry hardware (bit, frame, and subframe synchronizers) decommutated the flight data under control of the computer.

The flight data recording tape was played back at 1/4 speed so that the data sample rate would not exceed the output hardware I/Ø capabilities of the existing system software and hardware. Data then was provided at 5ms intervals (corresponding to Dryden's 200 samples per second existing data acquisition systems) on a hard copy line printer (see Appendix 3).

Flight data which was taken by hand in the aircraft was IRIG-B time correlated with that data which was displayed on the real time strip charts. Key time increments were then requested for the hard copy output. The hard copy PCM data was compared with that data obtained by hand and with that obtained from the real time strip charts in Appendix 3. From the examples illustrated in Appendix 3 it can be seen that the hand recorded data and the hard copy printout data correlate very closely with each other (±6 counts deviation). The strip chart data probably is also as accurate, however, the scale factor necessitates much coarser readings.

4.1.4 Goal #4: Study of Accuracy and Resolution of the AIFTDS System in a Flight Environment

Since hard copy PCM data has been made available to the AIFTDS team only recently, a complete analysis on the flight data may not be completed for some time. However, some accuracy and resolution analysis has been performed on some of the precision voltage inputs.

For these precision voltage input channels, several hundred samples were statistically analyzed. The occurrence of data values greater than 5 counts away from the norm were noted (see Appendix 3). Data point deviations on the order of 2 or 3 counts (for channels without presample filtering) were considered to be caused by instrumentation noise and/or thermal noise. From the analysis performed on these data it was determined that a deviation of 5 counts or more occurred less than once every 850 data values. For the most part, these large deviations were on the order of several hundred counts from the normal. The source of these large excursions has yet to be determined, although several possibilities have been brought to light. Instrumentation anomalies as well as anomalies in the ground station hardware are thought to be the most probable causes.

Appendix 3 illustrates several examples of precision voltage data. It is doubtful that the flight environment had any detrimental effects on the data validity save for an occasional noise anomaly. It is also obvious that the system can be made more immune to the aircraft noise environment with sound instrumentation engineering practices.

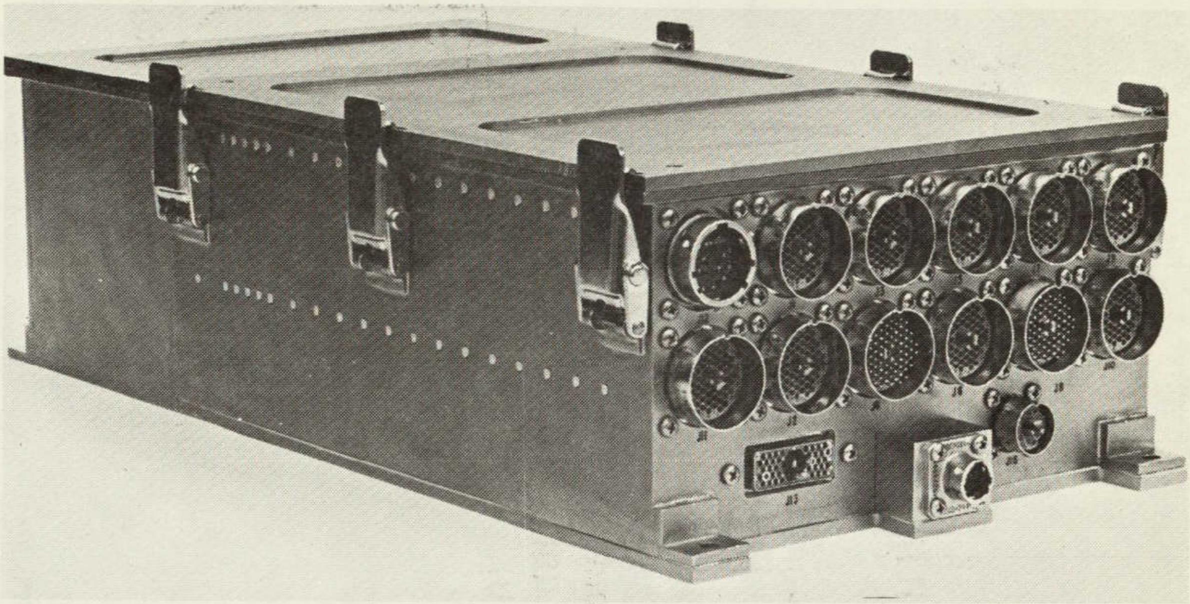
4.2 Impact of 12 Bit PCM Systems in Today's Aerospace Environment

NASA Dryden Flight Research Center's experience in high resolution data acquisition systems took a major step forward in the mid 1960's with the advent of a 9 bit PCM system. This PCM system, called the CT-77, has served as the backbone of Dryden Flight Research Center's data acquisition systems. With the recent breakthroughs in hybrid analog circuitry, PCM systems with resolutions in excess of 10 bits have been finding their way into the instrumentation engineer's arsenal. However, it is too soon to tell what effect, if any, this increase in resolution will have on PCM data acquisition systems.

One major advantage of a higher resolution, higher bit PCM data acquisition system (say 12 bits) over a 9 bit system is the increase in usable dynamic range available in the 12 bit system. Thus, by allowing each count to represent the same level there will be nearly one decade of range increase in the 12 bit system over the 9 bit system. This obviously allows for greater simplicity in data reduction (engineering units conversion, etc.) as well as allows for more leeway in the original estimation of output signal levels.

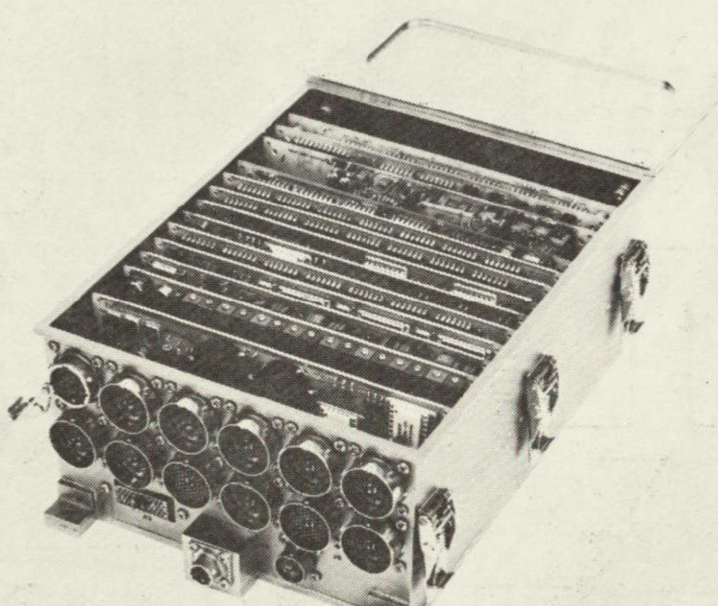
Another advantage is the obvious increase in sensitivity for the same dynamic full scale range. The same full scale range for a 12 bit system will allow an 8:1 increase in gain or resolution of each count over the 9 bit system. This advantage, however, also creates its own problems, e.g., the instrumentation engineer must properly shield and condition the transducers. Shielding and signal conditioning of transducers must be adequate to minimize common mode, differential mode, and ground loop coupling and other sources of data contamination. Since, in the case of aircraft instrumentation, there are usually many sensors located at remote locations referenced to the airframe potential in some manner, it is nearly impossible to eliminate one or all of these sources of error. This has a tendency to offset the advantages gained in the increased sensitivity (resolution per count) of the larger word size. There are, today, several groups of instrumentation engineers using the AIFTDS system with its increased word size and flexibility. NASA Ames, Douglas Aircraft Company, ERDA, and U.S. Air Force, to name only a few, have compiled many hours use with these systems - including many hours in a flight environment. Their experiences using the AIFTDS are well documented.

At NASA Dryden there are projects requiring accuracies on the order of 1/2% or better. These increases in accuracy requirements can be achieved easier with longer bit words; the quantizing error alone in an 8 bit system is on the order of .4% whereas it is only .025% in a 12 bit system. Hence, it is inevitable that the word length will have to increase if the dynamic range requirement or the accuracy requirement is to be satisfied. The penalties for this increase in word length are the increased care and engineering which must be exercised in instrumenting the newer system as well as the moderate increase in bandwidth required to keep the same word rate. The trade-offs are real and will have to be evaluated individually for each application.



Front View

Figure 1. AIFTDS standalone RMDU.



Top view (with cover removed) E 31053

Figure 1. Full AIFTDS system.

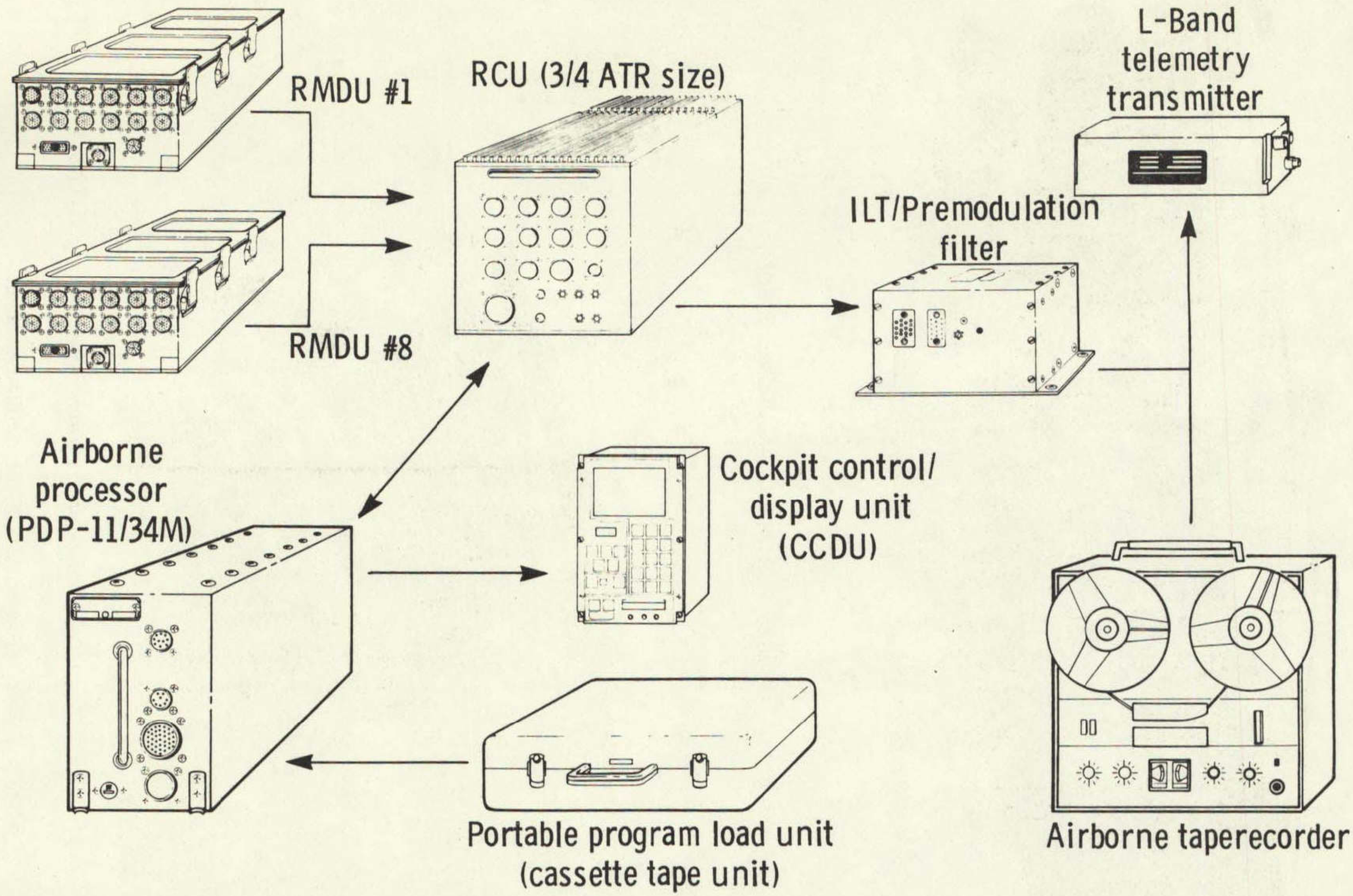
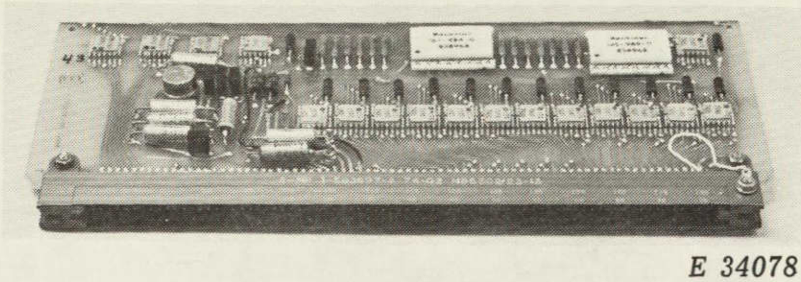
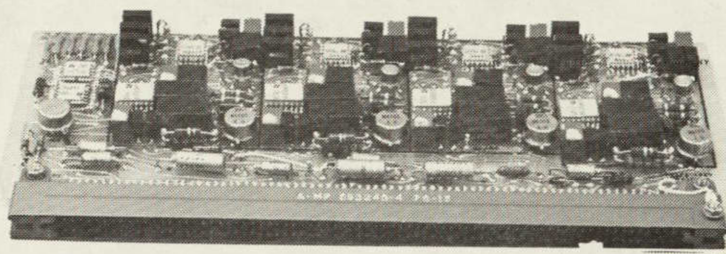


Figure 1. Full AIFTDS system.



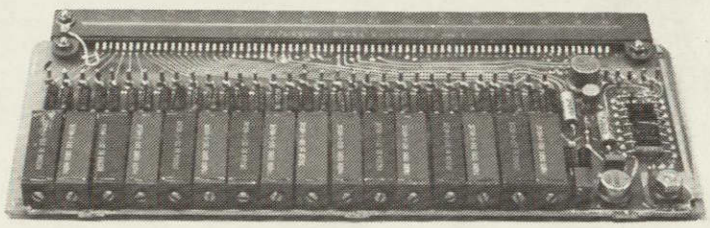
E 34078

(a) Analog muliplexer (AMX) card.



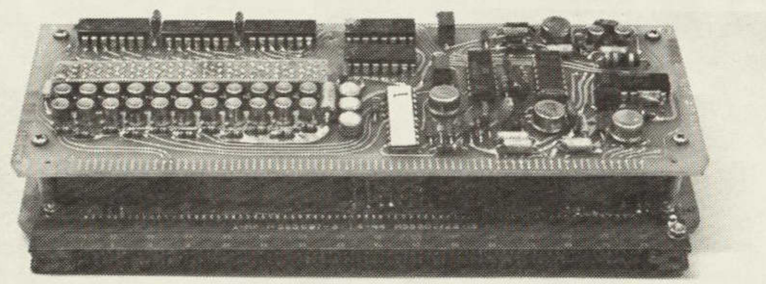
E 34077

(b) Presample filter/ amplifier (PSF) card.



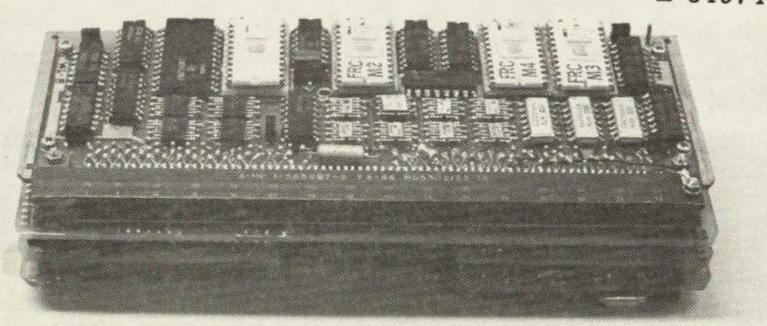
E 34075

(c) Excitation/bridge completion (EBC) card.



E 34074

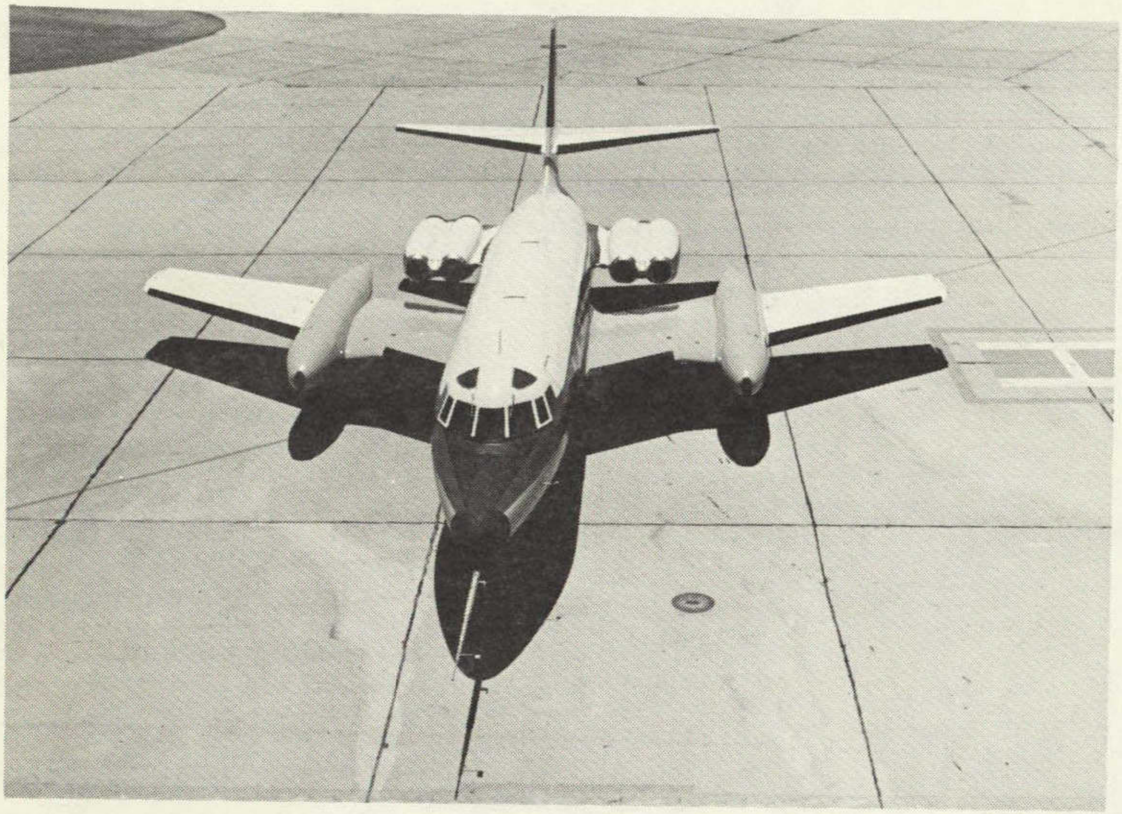
(d) Analog data processor module (ADP-M).



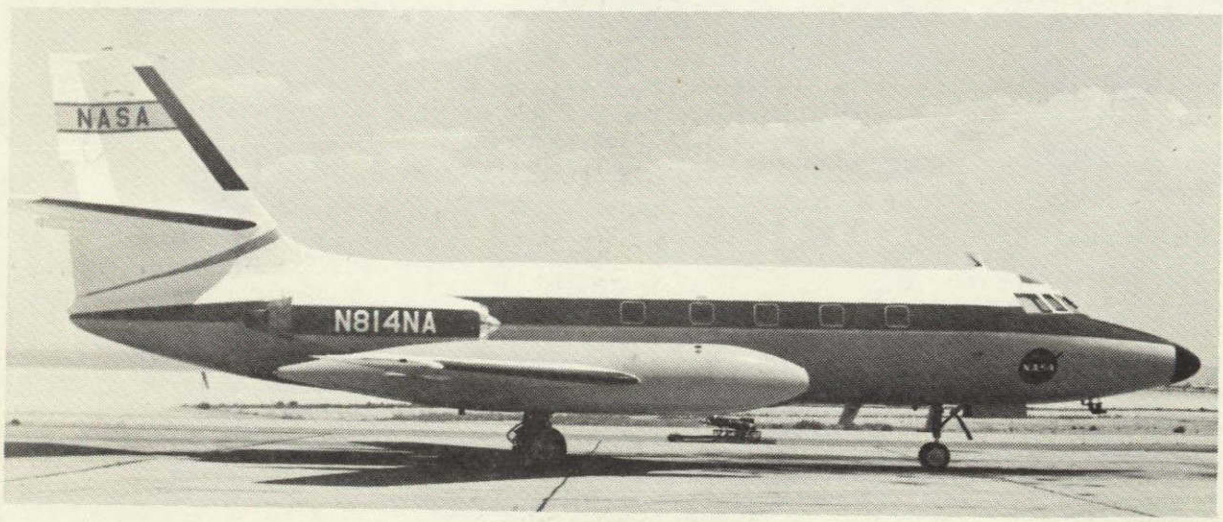
E 34073

(e) Stand-alone timing module (SAT-M).

Figure 2. RMDU plug-in modules.

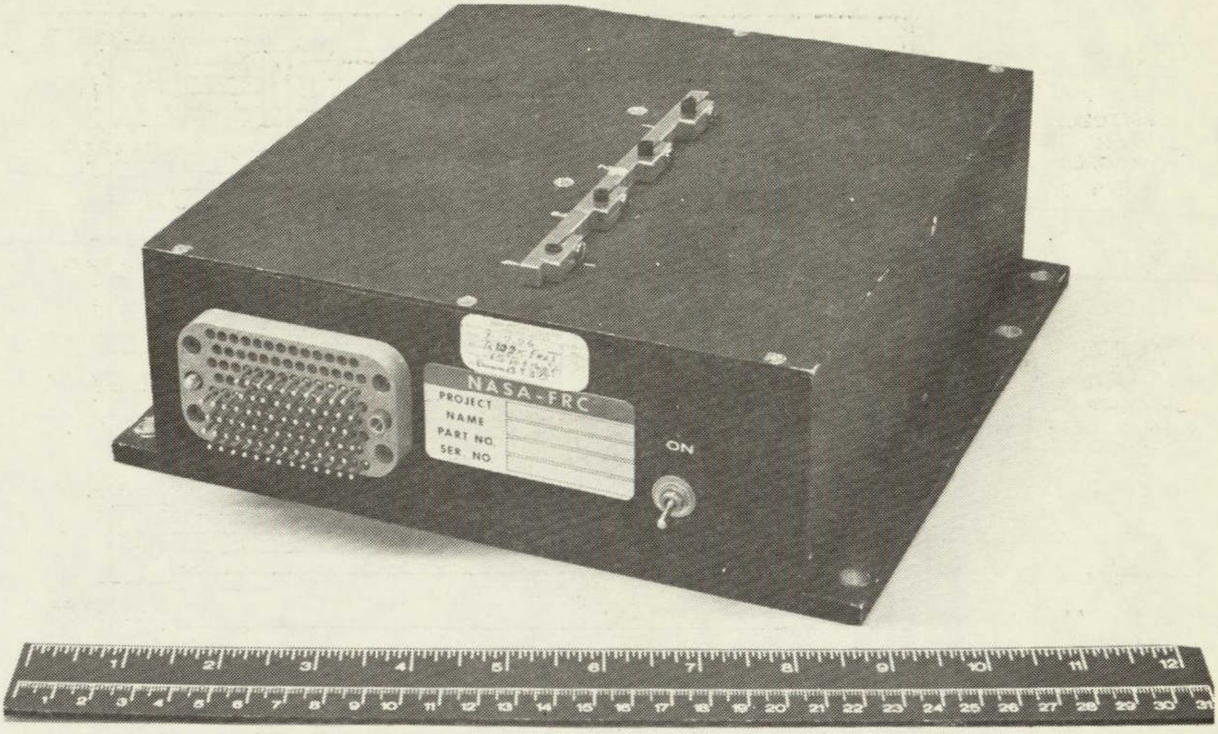


Jetstar front view ECN 4039

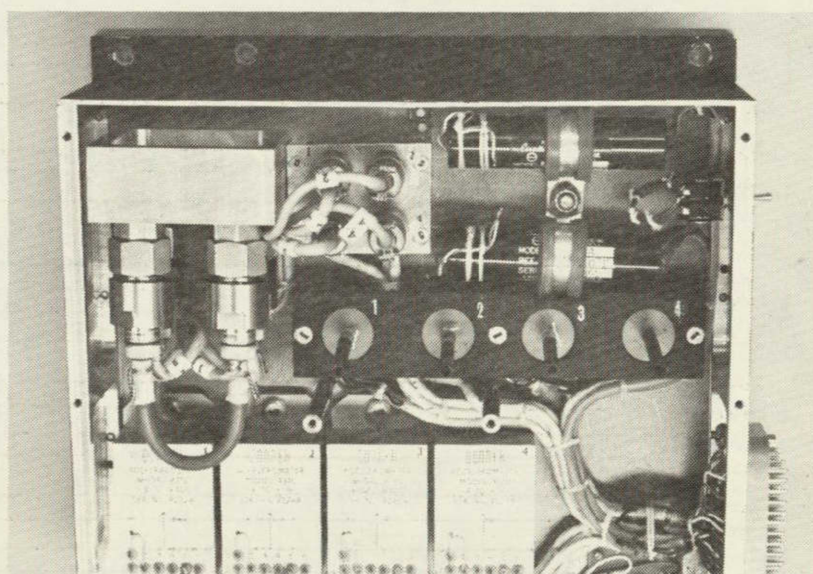


Jetstar side view ECN 2401

Figure 3. Jetstar.



Experimental sensor box with cover plate in place E 34082



Experimental sensor box with cover plate removed E 34081

Figure 4. Experimental sensor box.

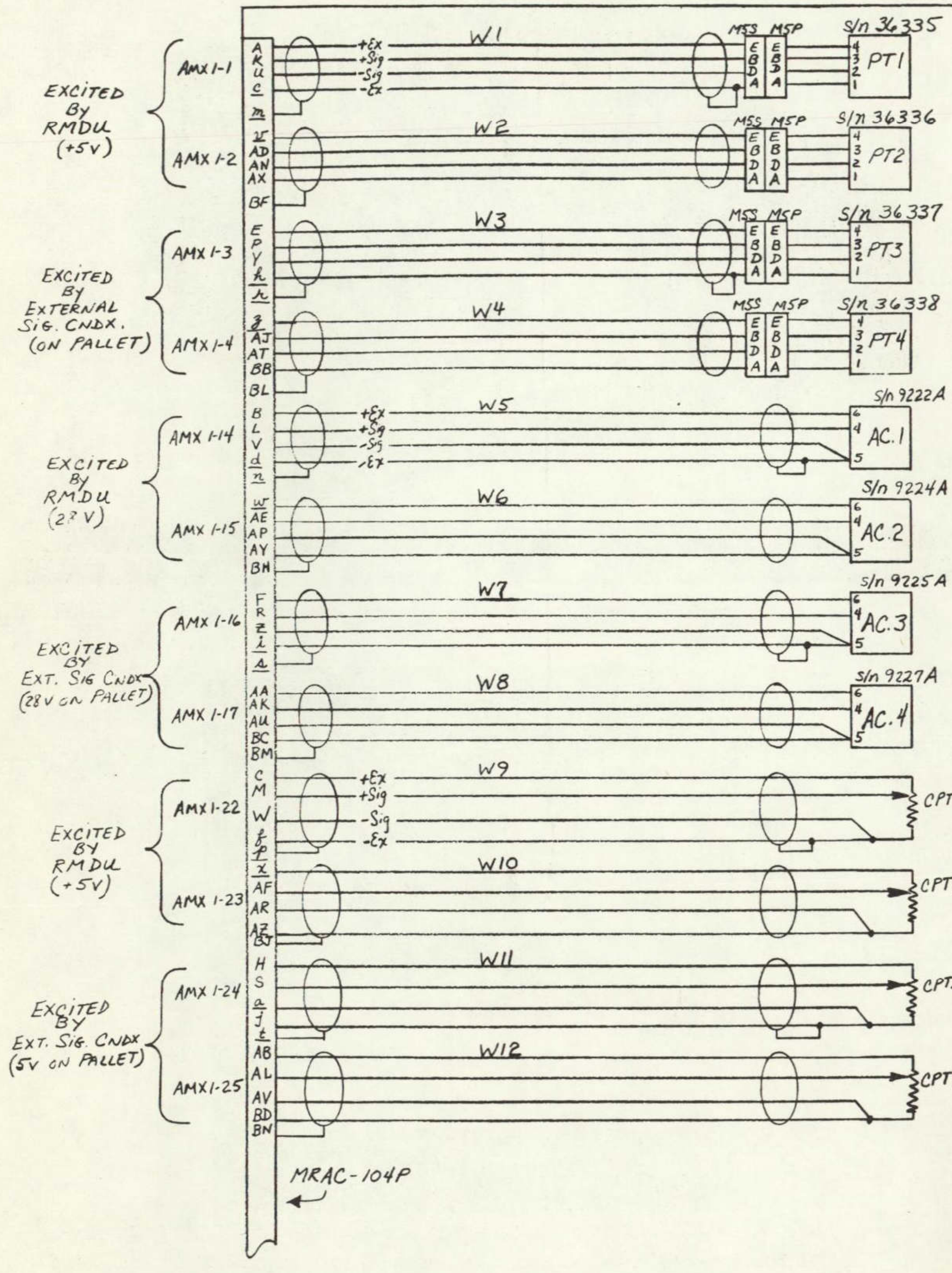
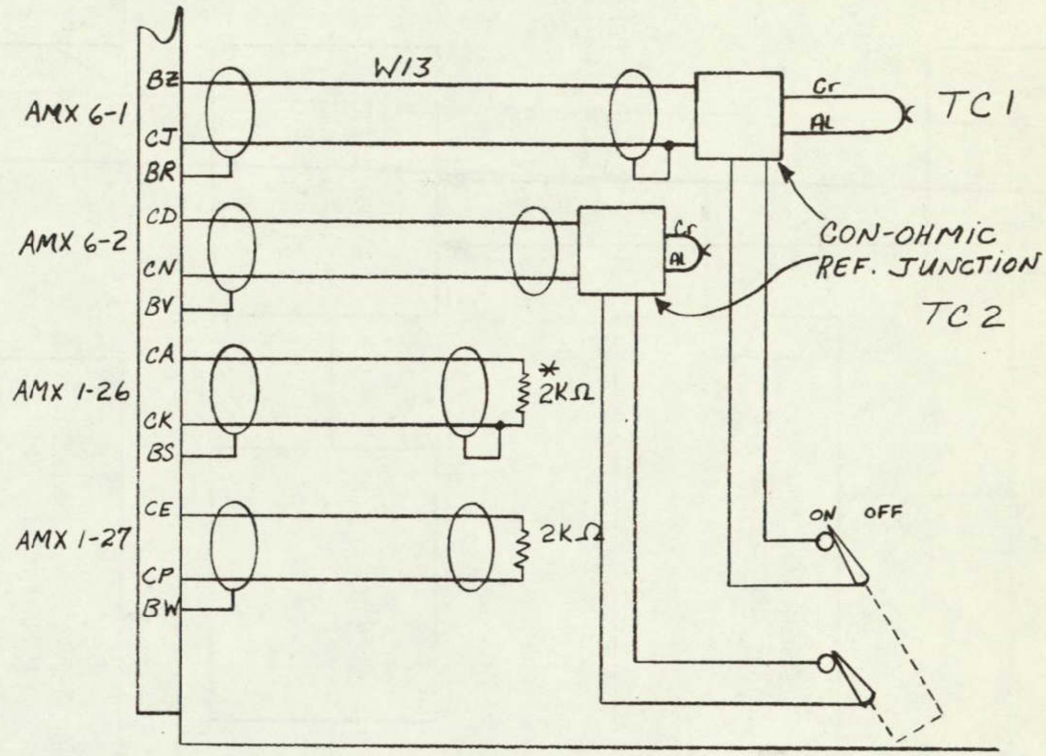


Figure 5. AIFTDS experimental box schematic (top section).



PT1 : STATHAM PM131TC-20D-350 ; 20 psiD ; 5V ; S/n 36335
PT2 : " S/n 36336
PT3 : " S/n 36337
PT4 : " S/n 36338
AC.1 : Donner ; 28V ; 10 G max ; .4v/G ; S/N 9222A
AC.2 " ; S/N 9224A
AC.3 " ; S/N 9225A
AC.4 " ; S/N 9227A
CPT1–CPT4 : 2KΩ HELIPOT
TC1 : Chromel-Allumel 21½ μv/°F
TC2 : "
2KΩ* : 2KΩ ; ⅛W , .1% wire wound
2KΩ : "

Figure 6. AIFTDS experimental box schematic (bottom section).

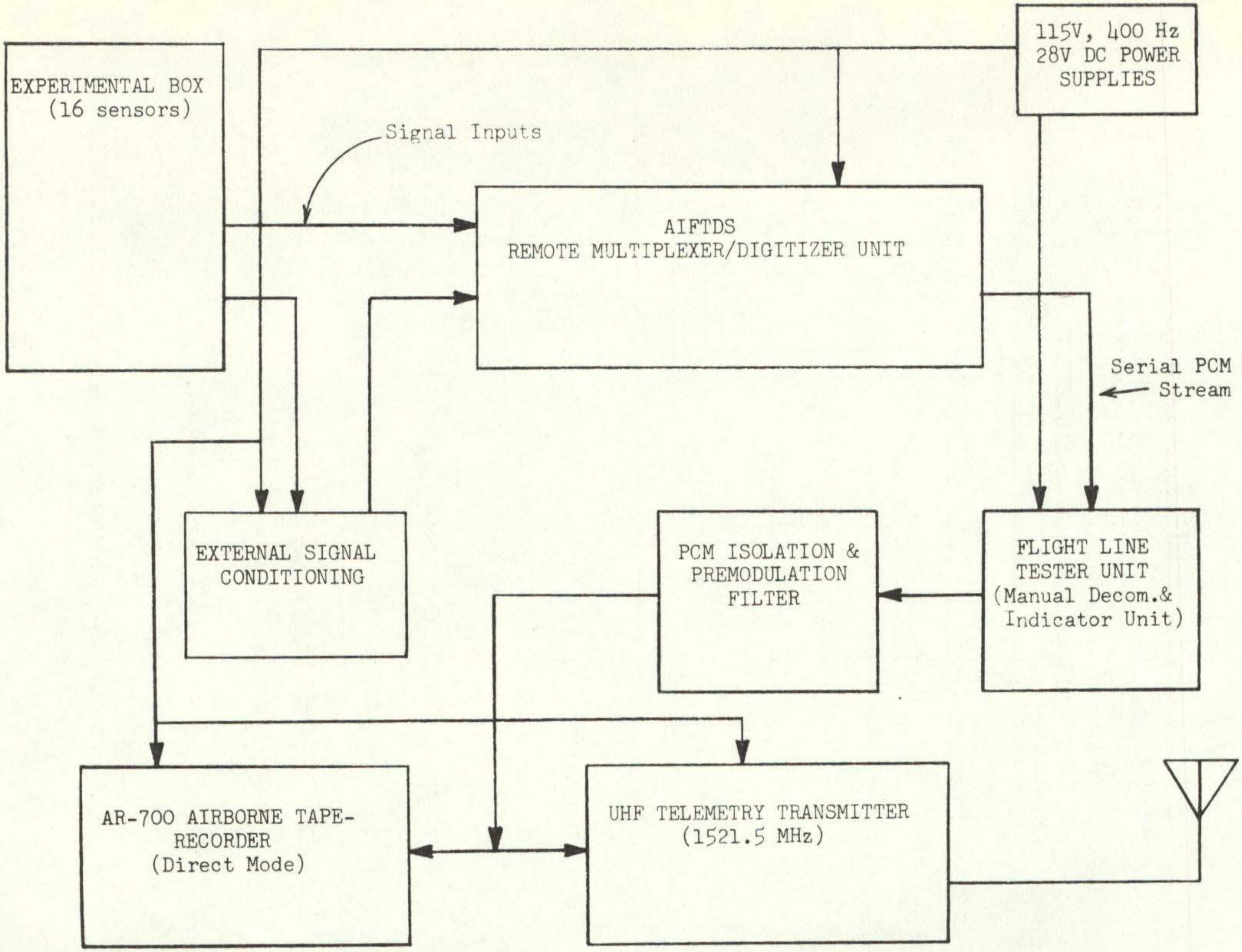
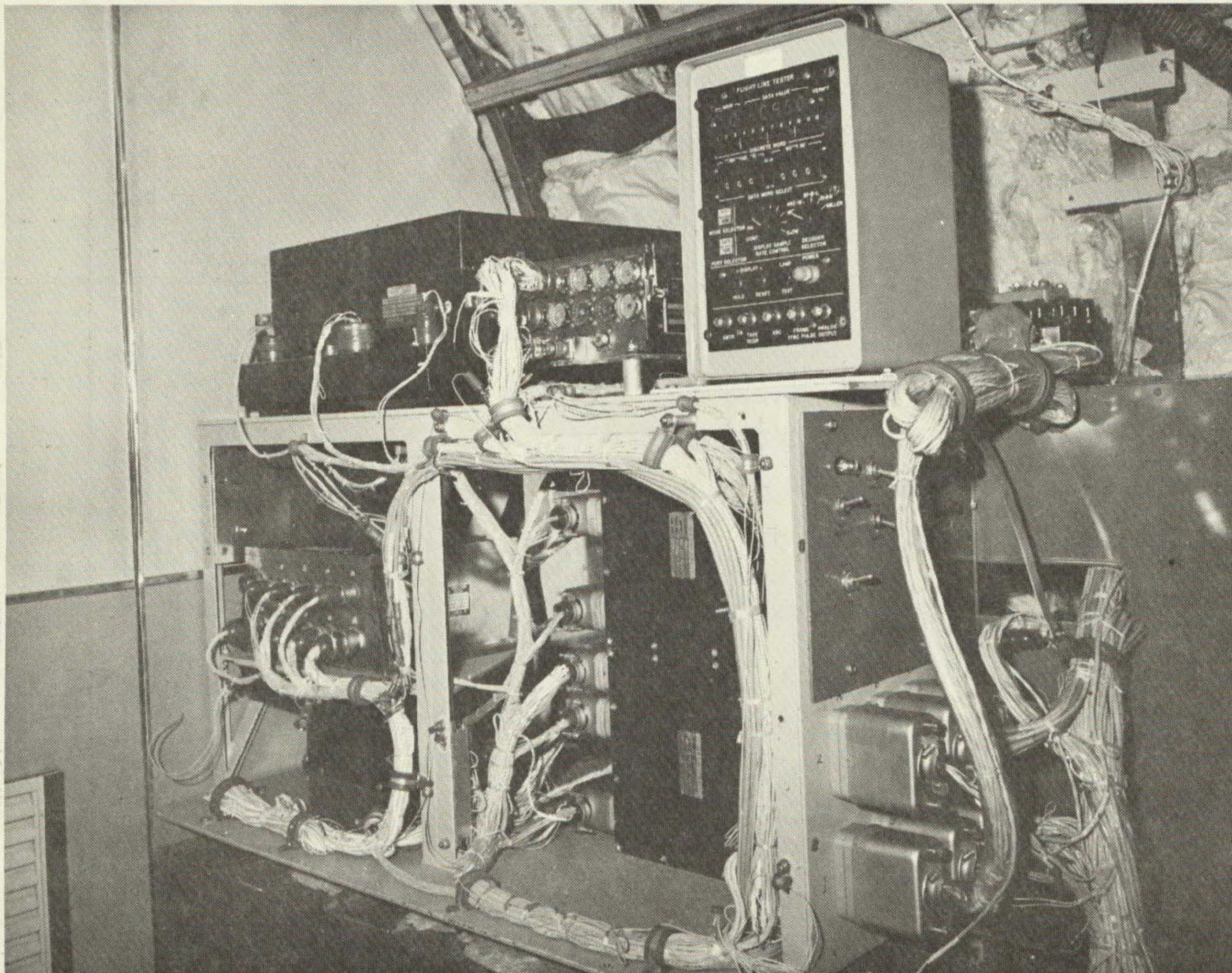


Figure 7. AIFTDS data acquisition system block diagram.



E 30828

Figure 8. Instrumentation pallet.

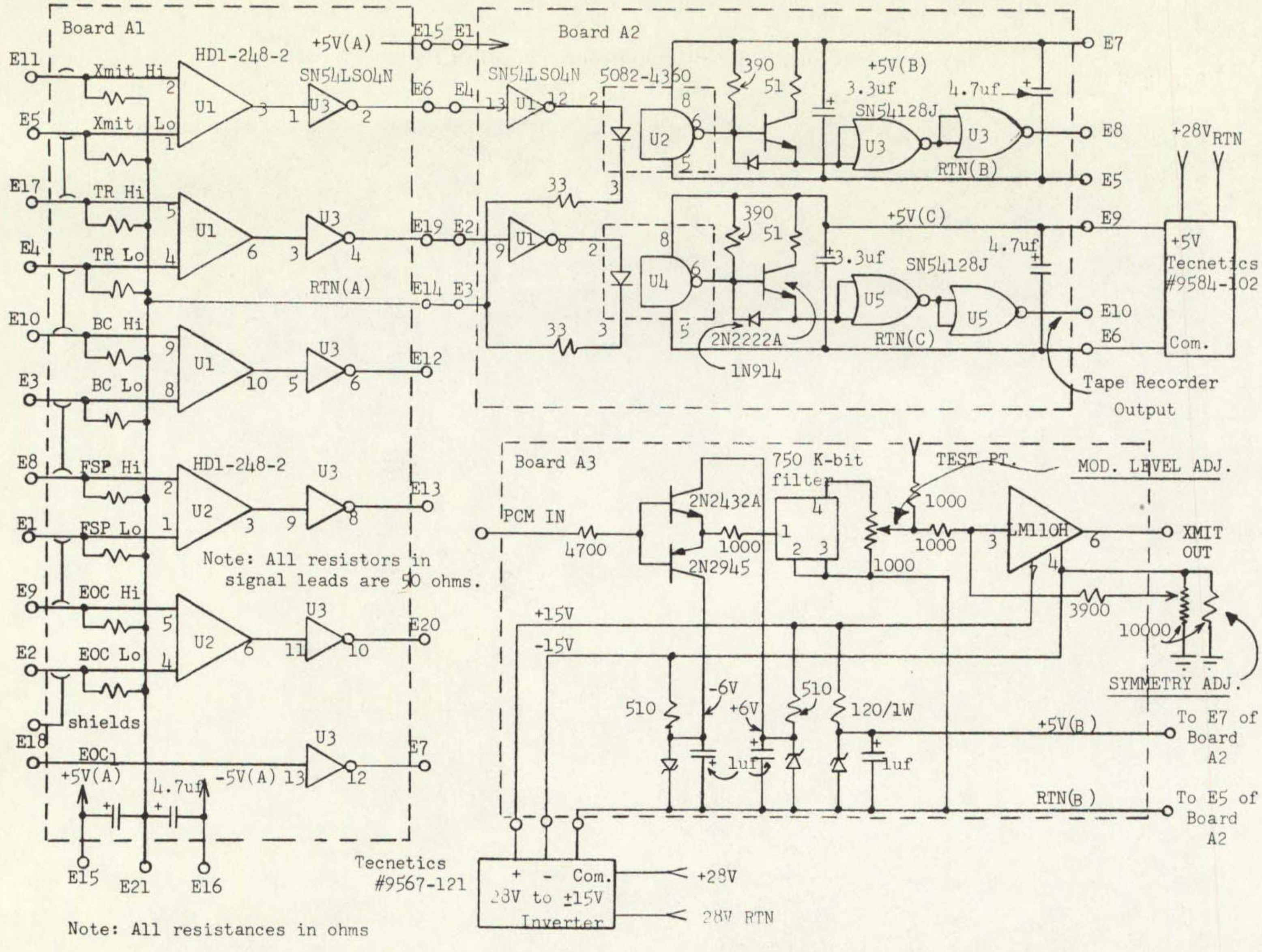


Figure 9. Schematic diagram of ILT/premodulation filter circuit.

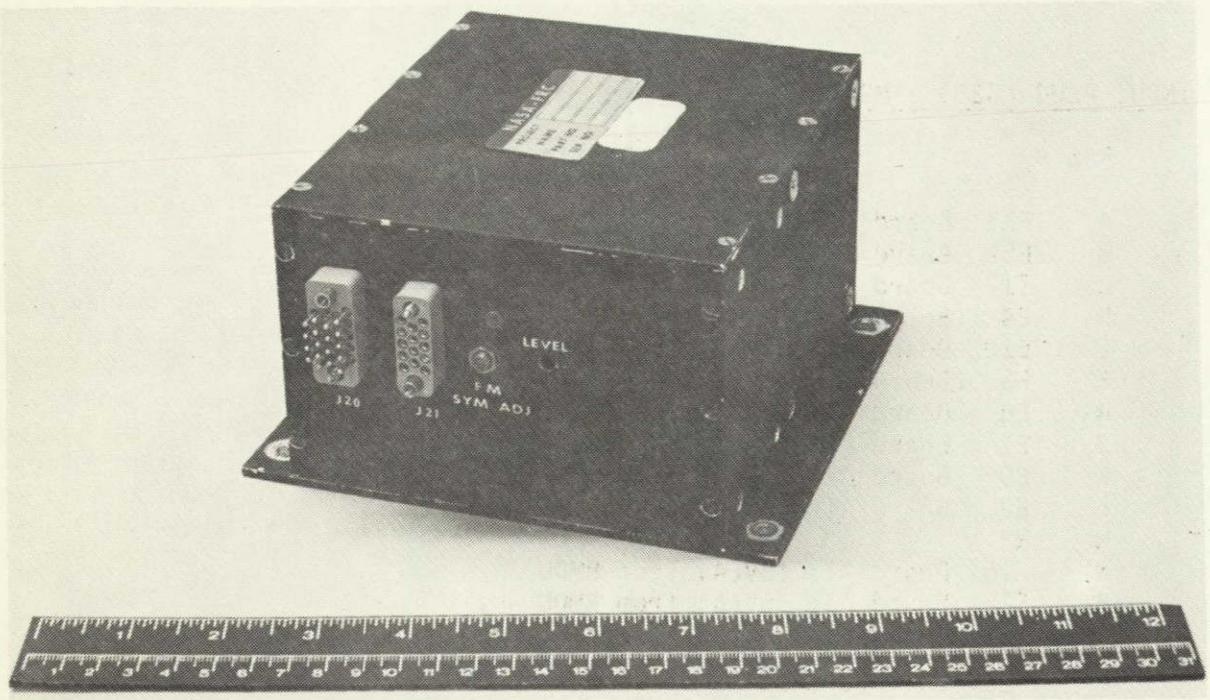
INPUT PLUG (J20): MRAC-18P

Pin #		Destination
A	E11	Board A1; XMIT Hi
B	E5	Board A1; XMIT Lo
C	E17	Board A1; TAPE RECORDER Hi
D	E4	Board A1; TAPE RECORDER Lo
E	E10	Board A1; BINARY CLOCK Hi
F	E3	Board A1; BINARY CLOCK Lo
H	E8	Board A1; FRAME SYNC PULSE Hi
J	E1	Board A1; FRAME SYNC PULSE Lo
K	E9	Board A1; END OF CYCLE Hi
L	E2	Board A1; END OF CYCLE Lo
M	N2	
N	E15	Board A1; +5V(A) from RMDU
P	E16	Board A1; -5V(A) from RMDU
R	E18	Board A1; EOC_1 TTL level signal from RMDU
S	+28V to inverters	
T	28V RTN to inverters	
U	Shields	
V	E14	Board A1; RTN(A) from RMDU

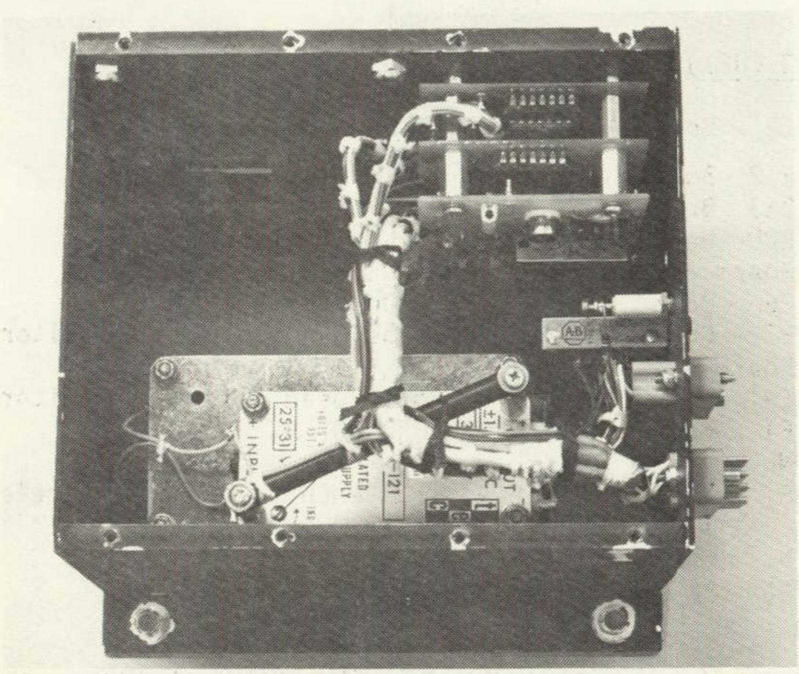
OUTPUT PLUG (J21): MRAC-14S

A	E7	Board A1; ECC_1 TTL level signal
B	E12	Board A1; BINARY CLOCK TTL level
C	E13	Board A1; FRAME SYNC PULSE TTL level
D	E20	Board A1; END OF CYCLE TTL level
E	Board A3; XMIT OUT RTN	
F	E6	Board A2; TAPE RECORD OUT RTN
H	E7	Board A2; +5V(B) to be used only as a monitor point
J	Board A3; XMIT OUT Hi	
K	E9	Board A2; +5V(C) to be used only as a monitor point
L	E10	Board A2; TAPE RECORD OUT Hi
M	NC	
N	E7	Board A1; RTN(A) from RMDU to be used as reference with pins A,B,C,D
P	NC	
R	NC	

Figure 10. ILT/premodulation filter internal wiring schematic.



ILT/premodulation filter box with cover plate in place E 34083



ILT/premodulation filter box with cover plate removed E 34080

Figure 11. ILT/premodulation filter box.

Bit #	11	10	9	8	7	6	5	4	3	2	1	0

Format: MSB LSB

Note: The MSB (Most Significant Bit) is the Gain Tag bit; when MSB = 0 the gain that was programmed is used, when MSB = 1 the programmed gain is reduced by ½ through the auto-ranging amplifier circuit. The MSB is transmitted first. The remaining 11 bits are in offset binary format.

Examples:

	MSB											LSB	Decimal Equivalent Translation
-1024*	1	0	0	0	0	0	0	0	0	0	0	0	(0-1024) x 2 = -2048
-768*	1	0	0	1	0	0	0	0	0	0	0	0	(256-1024) x 2 = -1536
-633*	1	0	0	1	1	0	0	0	0	1	1	1	(391-1024) x 2 = -1266
-512	0	0	1	0	0	0	0	0	0	0	0	0	(512-1024) x 1 = -512
-256	0	0	1	1	0	0	0	0	0	0	0	0	(768-1024) x 1 = -256
-64	0	0	1	1	1	1	0	0	0	0	0	0	(960-1024) x 1 = -64
-1	0	0	1	1	1	1	1	1	1	1	1	1	(1023-1024) x 1 = -1
0	0	1	0	0	0	0	0	0	0	0	0	0	(1024-1024) x 1 = 0
+120	0	1	0	0	0	1	1	1	1	0	0	0	(1144-1024) x 1 = 120
+768	0	1	1	1	0	0	0	0	0	0	0	0	(1792-1024) x 1 = 768
+480*	1	1	0	1	1	1	1	0	0	0	0	0	(1504-1024) x 2 = 960
+512*	1	1	1	0	0	0	0	0	0	0	0	0	(1536-1024) x 2 = 1024
+896*	1	1	1	1	1	0	0	0	0	0	0	0	(1920-1024) x 2 = 1792
+1023	1	1	1	1	1	1	1	1	1	1	1	1	(2047-1024) x 2 = 2045

* indicates that bit #11 (MSB:Gain Tab Bit) has been set

APPENDIX 1

DESCRIPTION OF RMDU MODULES USED IN FLIGHT TEST

AMX card: provides 33 addressable low level analog multiplexed channels, one channel of which is devoted to a precision voltage divider providing a 7.3237 mv signal useful for calibration purposes.

PSF card: provides four independent 4-pole active filter, preamplifiers per card. Dryden's were designed as 50 Hz cutoff, low pass Butterworth filters with gains of 1, 2, and 400.

ADP-M module: the analog data processing module, the heart of the analog processing portion of the RMDU, consists of a gain programmable amplifier, the autoranging circuitry, and the analog to digital (A/D) converter. The amplifier for the Dryden ADP-M has eight programmable gains (1,2,3,10,50,100,400, and 1000). The autoranging section samples the output of the gain programmable amplifier and automatically reduces the gain to ½ of its original value when the output exceeds approximately ±90% of full scale. Upon autoranging, a bit is appended to the most significant portion of the data word (see diagram below). The A/D converter portion of the ADP-M is an eleven-bit bipolar successive approximation converter with a resolution of 5 mv/count (thus giving an overall voltage range to the A/D converter of ±5.115 volts). Dryden's ADP-M is configured for offset binary output coding to remain compatible with the Center's existing ground station capabilities.

ADP-M OUTPUT WORD FORMAT:

MSB	11	10	9	8	7	6	5	4	3	2	1	0	LSB

11 data bits (bits 10–0)

GAIN TAG BIT (bit 11)
Ø = ORIGINAL GAIN
1 = ½ ORIGINAL GAIN

OFFSET BINARY	VOLTAGE INPUT
00000000000	= -F.S.
10000000000	= ZERO
11111111111	= +F.S.

The eight programmable gains give an overall resolution and full scale values as follows:

GAIN	RESOLUTION		FULL SCALE VOLTAGE INPUT	
1	5mv/count	* 10 mv/count	±5.1150 Volts	±10.2300 Volts
2	2½mv/count	* 5 mv/count	±2.5575 Volts	±5.1150 Volts
3	1-2/3mv/count	* 3-1/3mv/count	±1.7050 Volts	±3.4100 Volts
10	500μv/count	* 1 mv/count	±0.5115 Volts	±1.023 Volts
50	100μv/count	* 200μv/count	±0.1023 Volts	±.2046 Volts
100	50μv/count	* 100μv/count	±51.150 mv	±.10230 Volts
400	12½μv/count	* 25μv/count	±12.789 mv	±25.5750 mv
1000	5μv/count	* 10μv/count	±5.115 mv	±10.2300 mv

* indicates autoranged values

SAT-M module: generates all internal and external time base signals, contains the sampling format memory for the data cycle, and formats the 12 bit digital data for transmission recording on an onboard tape recorder, or both. The available output formats are nonreturn to zero level (NRZ-L), nonreturn to zero Mark (NRZ-M) biphase level (BiØ-L), biphase mark (BiØ-M), and delay modulation mark (DM-M or Miller).

Dryden's SAT-M was configured for NRZ-L format to the RF transmitter, and DM-M format to the onboard tape recorder. The maximum word rate obtained with the SAT-M is 125,000 WPS (1.5 Mbits/sec).

Dryden's was configured for a word rate of 13,888 WPS (167 Kbits/sec) - again keeping compatible with the existing station firmware setup. The sampling format for the data cycle map is stored in erasable programmable read-only memories (EPROM's) located in the SAT-M. The data cycle sampling format memory contains the information that directs the RMDU channel sampling sequence, gain, and sampling rate. The user has a great deal of flexibility in designing the sampling format memory, however, certain limits and constraints should be observed.

Any number of mainframe channels can be specified up to and including 128 (which includes the synchronization words and the subframe identification word). Similarily, any number of subframe channels can be specified (not to exceed 128 unique parameters) as long as the product of the number of subframe columns and the depth of the deepest subframe column does not exceed 256. These constraints are entirely based upon the size of the memory circuits; newer SAT-M modules are available now from the manufacturer which have considerably larger memory circuits. The NASA Dryden sampling format was comprised of 16 words per frame with the deepest subframe channels (see figures in Appendix 2).

APPENDIX 2

DRYDEN'S SAMPLING FORMAT FOR USE IN FLIGHT TEST

Subframe No. / Word No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	SYNCH-1 Ø112$_8$	SYNCH-2 Ø27Ø$_8$	SF-ID 7ØØØ$_8$	HLC	LLC-1 X400	AMX 1-5 X400	GPA-Ø X400	AMX * 1-1 X400	AMX 1-10 X1000	AMX ** 1-1 X1000	LLC-1 X1000	GPA-Ø X10	AMX 1-14 X10	AMX 1-14 X3	AMX* 1-22 X2	AMX 1-23 X2
1			SF-ID 7ØØ1$_8$				GPA-Ø X400	AMX * 1-2 X400	AMX 1-11 X1000	AMX ** 1-2 X1000	LLC-1 X1000	GPA-Ø X10	AMX 1-15 X10	AMX 1-15 X3	AMX 1-24 X2	AMX 1-25 X2
2			SF-ID 7ØØ2$_8$					AMX 1-3 X400	AMX 1-26 X1000	AMX 1-3 X1000	LLC-1 X1000	AMX 1-12 X10	AMX 1-16 X10	AMX 1-16 X3	AMX * 1-22 X1	AMX 1-23 X1
3			SF-ID 7ØØ3$_8$					AMX 1-4 X400	AMX 1-27 X1000	AMX 1-4 X1000	LLC-1 X1000	AMX 1-13 X10	AMX 1-17 X10	AMX 1-17 X3	AMX 1-24 X1	AMX 1-25 X1
4			SF-ID 7ØØ4$_8$												AMX * 6-1 X400	AMX 6-2 X400
5			SF-ID 7ØØ5$_8$												AMX ** 6-1 X1000	AMX 6-2 X1000
6			SF-ID 7ØØ6$_8$												AMX 1-26 X400	AMX 1-27 X400
7			SF-ID 7ØØ7$_8$												PSB	LLC-1 X100

Bit Rate = 167 Kbits/sec
Word Rate = 13,888 Words/sec
No. Bits/Word = 12
Sample Rate:
Main Frame Words = 868 Samples/sec
2-Deep Subframe Words = 434 Samples/sec
4-Deep Subframe Words = 217 Samples/sec
8-Deep Subframe Words = 108½ Samples/sec

Note: astericks denote minor changes for Flights 479 and 481 in that those channels so marked are preceded by a 50 Hz four-pole Butterworth filter

* overall gain of these channels are same; the gain programmable amplifier is reduced to unity and the remaining gain occurring in the active filter

** overall gain of these channels are reduced from 1000 to 800; the gain programmable amplifier is reduced to a gain of 2 with the active filter providing a gain of 400.

LINE #	PARAMETER	DESCRIPTION	GAIN	SAMPLE RATE (Samples/sec)
1	SYNC-1	Barker Code: $0112)_8$	-	868
2	SYNC-2	Barker Code: $0270)_8$		868
3	SF-ID Ø	$7000)_8$		108½
4	HLC	High Level Calibration	-	868
5	LLC-1 (AMX 1-33)	Low Level Calibration	400	868
6	AMX 1-5	Shorted at RMDU plug	400	868
7	GPA-Ø	GPA zero calibration	400	434
8	AMX 1-1	PT1 Driven shield, RMDU excitation	400	217
9	AMX 1-10	Shorted at RMDU plug	1000	217
10	AMX 1-1	PT1 Driven Shield, RMDU excitation	1000	217
11	LLC-1(AMX 1-33)	Low level calibration	1000	217
12	GPA-Ø	GPA zero calibration	10	217
13	AMX 1-14	AC.1 Driven shield, RMDU excitation	10	217
14	AMX 1-14	AC.1 Driven shield, RMDU	3	217
15	AMX 1-22	CPT1 Driven shield, RMDU excitation	2	108½
16	SF - ID 1	$7001)_8$	-	108½
17	AMX 1-2	PT2 Non-driven shield, RMDU excitation	400	217
18	AMX 1-11	Shorted at RMDU plug	1000	217
19	AMX 1-2	PT2 Non-driven shield, RMDU bias	1000	217
20	AMX 1-15	AC-2 Non-driven shield, RMDU excitation	10	217

LINE #	PARAMETER	DESCRIPTION	GAIN	SAMPLE RATE
21	AMX 1-15	AC-2 Non-driven shield, RMDU Excitation	3	217
22	AMX 1-24	CPT3 Driven shield External Excitation	2	108½
23	AMX 1-25	CPT4 Non-driven shield, External Excitation	2	108½
24	SF-ID 2	$7002)_8$	-	108½
25	AMX 1-3	PT3 Driven shield External Excitation	400	217
26	AMX 1-26	2KΩ Driven shield	1000	217
27	AMX 1-3	PT3 Driven shield, External Excitation	1000	217
28	AMX 1-12	Shorted at RMDU plug	10	217
29	AMX 1-16	AC.3 Driven shield, External Excitation	10	217
30	AMX 1-16	AC.3 Driven shield, External Excitation	3	217
31	AMX 1-22	CPT1 Driven shield, RMDU excitation	1	108½
32	AMX 1-23	CPT2 Non-driven shield RMDU excitation	1	108½
33	SF-ID 3	$7003)_8$	-	108½
34	AMX 1-4	PT4 Non-driven shield, External excitation	400	217
35	AMX 1-27	Tape recorder tachometer	1000	217
36	AMX 1-4	PT4 Non-driven shield, External Bias	1000	217
37	AMX 1-13	Shorted at RMDU plug	10	217
38	AMX 1-17	Ac4 Non-driven shield, External Excitation	10	217
39	AMX 1-17	Ac4 Non-driven shield External Excitation	3	217
40	AMX 1-24	CPT3 Driven shield, External Excitation	1	108½
41	AMX 1-25	CPT4 Non-driven shield, External Excitation	1	108½
42	SF-ID 4	$7004)_8$	-	108½
43	AMX 6-1	TC-1 Driven shield	400	108½
44	AMX 6-2	TC-2 Non-driven shield	400	108½
45	SF-ID 5	$7005)_8$	-	108½
46	AMX 6-1	TC-1 Driven shield	1000	108½
47	AMX 6-2	TC-2 Non-driven shield	1000	108½
48	SF-ID 6	$7006)_8$	-	108½
49	AMX 1-26	2KΩ* Driven shield	400	108½

LINE #	PARAMETER	DESCRIPTION	GAIN	SAMPLE RATE
50	AMX 1-27	Tape Recorder tachometer	400	108½
51	SF-ID 7	$7007)_8$	-	108½
52	PSB	Power supply BITE	-	108½
53	LLC-1(AMX 1-33)	Low level calibration	100	108½

MEMORY ADDRESS	PARAMETER	GAIN	A Code 4 3 2 1 D 7	G Code 4 3 2 1 D 0	Y Code 3 2 1 D 7	X Code 3 2 1	C Code 2 1 D 0		Octal
0	SYNC 1	-	0 0 0 0	0 1 0 0	1 0 1	0 0 0	0 0	nm	004 240
1	SYNC 2	-	0 0 0 0	1 0 1 1	1 0 0	0 0 0	0 0	nm	013 200
2	SF-ID	-	1 1 1 0	0 0 0 0	0 0 0	0 0 0	0 0	nm	340 000
3	HLC	-	1 1 1 1	0 0 0 0	0 0 0	0 0 0	0 0	nm	360 000
4	LLC-1	400	0 1 0 0	0 0 1 0	1 0 1	0 1 0	0 0	nm	102 250
5	AMX 1-5	400	0 1 0 0	0 0 1 0	0 0 0	1 0 0	0 1	nsf	102 021
.	.	.		.		.		.	.
.	.	.		.		.		.	.
.	.	.		.		.		.	.
128	GPA-Ø	400	1 1 1 0	0 0 1 0	0 0 0	0 0 0	0 1	nsf	342 001
129	AMX 1-1	400	0 1 0 0	0 0 1 0	0 0 0	0 0 0	0 1	nsf	102 001
130	AMX 1-10	1000	0 1 0 0	0 0 0 1	0 0 1	0 1 1	0 1	nsf	101 055
131	AMX 1-1	1000	0 1 0 0	0 0 0 1	0 0 0	0 0 0	0 1	nsf	101 001
132	LLC-1	1000	0 1 0 0	0 0 0 1	1 0 1	0 1 0	0 1	nsf	101 251
133	GPA-Ø	10	1 1 1 0	0 1 0 1	0 0 0	0 0 0	0 1	nsf	345 001
134	AMX 1-14	10	0 1 0 0	0 1 0 1	1 0 0	0 0 1	0 1	nsf	105 105
135	AMX 1-14	3	0 1 0 0	1 0 0 0	1 0 0	0 0 1	0 1	nsf	110 105
136	AMX 1-22	2	0 1 0 0	1 0 0 1	0 1 1	0 1 1	0 1	nsf	111 155
137	AMX 1-23	2	0 1 0 0	1 0 0 1	0 1 1	1 0 0	1 0	eof	111 162
138	GPA-Ø	400	1 1 1 0	0 0 1 0	0 0 0	0 0 0	0 1	nsf	342 001
139	AMX 1-2	400	0 1 0 0	0 0 1 0	0 0 0	0 0 1	0 1	nsf	102 005
140	AMX 1-11	1000	0 1 0 0	0 0 0 1	0 0 1	1 0 0	0 1	nsf	101 061
141	AMX 1-2	1000	0 1 0 0	0 0 0 1	0 0 0	0 0 1	0 1	nsf	101 005
142	LLC-1	1000	0 1 0 0	0 0 0 1	1 0 1	0 1 0	0 1	nsf	101 251
143	GPA-Ø	10	1 1 1 0	0 1 0 1	0 0 0	0 0 0	0 1	nsf	345 001
144	AMX 1-15	10	0 1 0 0	0 1 0 1	1 0 0	0 1 0	0 1	nsf	105 111
145	AMX 1-15	3	0 1 0 0	1 0 0 0	0 1 0	0 1 0	0 1	nsf	110 111
146	AMX 1-24	2	0 1 0 0	1 0 0 1	0 1 1	1 0 1	0 1	eof	111 165
147	AMX 1-25	2	0 1 0 0	1 0 0 1	1 0 0	0 0 0	1 0	nsf	111 202
148	AMX 1-3	400	0 1 0 0	0 0 1 0	0 0 0	0 1 0	0 1	nsf	102 011
149	AMX 1-26	1000	0 1 0 0	0 0 0 1	1 0 0	0 0 1	0 1	nsf	101 205
150	AMX 1-3	1000	0 1 0 0	0 0 0 1	0 0 0	0 1 0	0 1	nsf	101 011
151	LLC -1	1000	0 1 0 0	0 0 0 1	1 0 1	0 1 0	0 1	nsf	101 251
152	AMX 1-12	10	0 1 0 0	0 1 0 1	0 0 1	1 0 1	0 1	nsf	105 065
153	AMX 1-16	10	0 1 0 0	0 1 0 1	0 1 0	0 1 1	0 1	nsf	105 115
154	AMX 1-16	3	0 1 0 0	1 0 0 0	0 1 0	0 1 1	0 1	nsf	110 115
155	AMX 1-22	1	0 1 0 0	1 0 1 0	0 1 1	0 1 1	0 1	nsf	112 155
156	AMX 1-23	1	0 1 0 0	1 0 1 0	0 1 1	1 0 0	0 1	eof	112 162
157	AMX 1-4	400	0 1 0 0	0 0 1 0	0 0 0	0 1 1	0 1	nsf	102 015

EPROMS 1 and 2 MAIN FORMAT MEMORY PROGRAM

MEMORY ADDRESS	PARAMETER	GAIN	A Code 4 (EPROM 1 D7)	A Code 3	A Code 2	A Code 1	G Code 4	G Code 3	G Code 2	G Code 1 (EPROM 1 D0)	Y Code 3 (EPROM 2 D7)	Y Code 2	Y Code 1	X Code 3	X Code 2	X Code 1	C Code 2	C Code 1 (EPROM 2 D0)		Octal EPROM 1	Octal EPROM 2
158	AMX 1-27	1000	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	1	nsf	101	211
159	AMX 1-4	1000	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	1	nsf	101	015
160	LLC-1	1000	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	1	nsf	101	251
161	AMX 1-13	10	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	1	nsf	105	101
162	AMX 1-17	10	0	1	0	0	0	1	0	1	0	1	0	1	0	0	0	1	nsf	105	121
163	AMX 1-17	3	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	1	nsf	110	121
164	AMX 1-24	1	0	1	0	0	1	0	1	0	0	1	1	1	0	1	0	1	nsf	112	165
165	AMX 1-25	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	1	0	eof	112	202
166	AMX 6-1	400	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	nsf	222	001
167	AMX 6-2	400	1	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	eof	222	006
168	AMX 6-1	1000	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	nsf	221	001
169	AMX 6-2	1000	1	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	eof	221	006
170	AMX 1-26	400	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	1	nsf	102	205
171	AMX 1-27	400	0	1	0	0	0	0	1	0	1	0	0	0	1	0	1	0	eof	102	212
172	PSB	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	nsf	000	001
173	LLC-1	100	0	1	0	0	0	0	1	1	1	0	1	0	1	0	1	1	eoc	103	253

Note: "C" Code:
nm = next mainframe
nsf = next subframe
eof = end of frame
eoc = end of cycle
A Code = Card Select
G Code = Gain Select
YX Code = Channel Select

EPROMS 1 and 2 MAIN FORMAT MEMORY PROGRAM (CONCLUDED)

	DATA CONTENTS								
MEMORY ADDRESS	DECIMAL VALUE	BINARY D_7	D	D	D	D	D	D	D_0
0	128	1	0	0	0	0	0	0	0
1	129	1	0	0	0	0	0	0	1
2	130	1	0	0	0	0	0	1	0
3	131	1	0	0	0	0	0	1	1
4	132	1	0	0	0	0	1	0	0
5	133	1	0	0	0	0	1	0	1
6	134	1	0	0	0	0	1	1	0
7	135	1	0	0	0	0	1	1	1
8	136	1	0	0	0	1	0	0	0
9	137	1	0	0	0	1	0	0	1
10	138	1	0	0	0	1	0	1	0
11	139	1	0	0	0	1	0	1	1
12	140	1	0	0	0	1	1	0	0
13	141	1	0	0	0	1	1	0	1
14	142	1	0	0	0	1	1	1	0
15	143	1	0	0	0	1	1	1	1
16	144	1	0	0	1	0	0	0	0
17	145	1	0	0	1	0	0	0	1
18	146	1	0	0	1	0	0	1	0
19	147	1	0	0	1	0	0	1	1
20	128	1	0	0	0	0	0	0	0
21	148	1	0	0	1	0	1	0	0
22	149	1	0	0	1	0	1	0	1
23	150	1	0	0	1	0	1	1	0
24	151	1	0	0	1	0	1	1	1
25	152	1	0	0	1	1	0	0	0
26	153	1	0	0	1	1	0	0	1
27	154	1	0	0	1	1	0	1	0
28	155	1	0	0	1	1	0	1	1
29	156	1	0	0	1	1	1	0	0
30	138	1	0	0	0	1	0	1	0
31	157	1	0	0	1	1	1	0	1
32	158	1	0	0	1	1	1	1	0
33	159	1	0	0	1	1	1	1	1
34	160	1	0	1	0	0	0	0	0
35	161	1	0	1	0	0	0	0	1
36	162	1	0	1	0	0	0	1	0
37	163	1	0	1	0	0	0	1	1
38	164	1	0	1	0	0	1	0	0
39	165	1	0	1	0	0	1	0	1

	DATA CONTENTS								
MEMORY ADDRESS	DECIMAL VALUE	BINARY D_7	D	D	D	D	D	D	D_0
40	128	1	0	0	0	0	0	0	0
41	129	1	0	0	0	0	0	0	1
42	130	1	0	0	0	0	0	1	0
43	131	1	0	0	0	0	0	1	1
44	132	1	0	0	0	0	1	0	0
45	133	1	0	0	0	0	1	0	1
46	134	1	0	0	0	0	1	1	0
47	135	1	0	0	0	0	1	1	1
48	166	1	0	1	0	0	1	1	0
49	167	1	0	1	0	0	1	1	1
50	138	1	0	0	0	1	0	1	0
51	139	1	0	0	0	1	0	1	1
52	140	1	0	0	0	1	1	0	0
53	141	1	0	0	0	1	1	0	1
54	142	1	0	0	0	1	1	1	0
55	143	1	0	0	0	1	1	1	1
56	144	1	0	0	1	0	0	0	0
57	145	1	0	0	1	0	0	0	1
58	168	1	0	1	0	1	0	0	0
59	169	1	0	1	0	1	0	0	1
60	128	1	0	0	0	0	0	0	0
61	148	1	0	0	1	0	1	0	0
62	149	1	0	0	1	0	1	0	1
63	150	1	0	0	1	0	1	1	0
64	151	1	0	0	1	0	1	1	1
65	152	1	0	0	1	1	0	0	0
66	153	1	0	0	1	1	0	0	1
67	154	1	0	0	1	1	0	1	0
68	170	1	0	1	0	1	0	1	0
69	171	1	0	1	0	1	0	1	1
70	138	1	0	0	0	1	0	1	0
71	157	1	0	0	1	1	1	0	1
72	158	1	0	0	1	1	1	1	0
73	159	1	0	0	1	1	1	1	1
74	160	1	0	1	0	0	0	0	0
75	161	1	0	1	0	0	0	0	1
76	162	1	0	1	0	0	0	1	0
77	163	1	0	1	0	0	0	1	1
78	172	1	0	1	0	1	1	0	0
79	173	1	0	1	0	1	1	0	1

SUBFRAME STEERING (EPROM 3) PROGRAM

	CONTENTS							
MEMORY	MSB							LSB
ADDRESS	D_7	D	D	D	D	D	D	D_0
0	1	1	1	1	0	0	1	0
1	1	1	1	1	1	0	1	0
2	1	1	1	1	1	0	0	1
3	1	1	1	1	1	1	1	1
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
255	1	1	1	1	1	1	1	1

Note: 0 in D_0 ....SYNC word(s)

0 in D_1 ....SF-ID word

0 in D_2 ....SYNC or ID word(s)

0 in D_3 ....1^{st} word in frame

OVERHEAD WORD LOCATOR (EPROM 4) PROGRAM

APPENDIX 3a

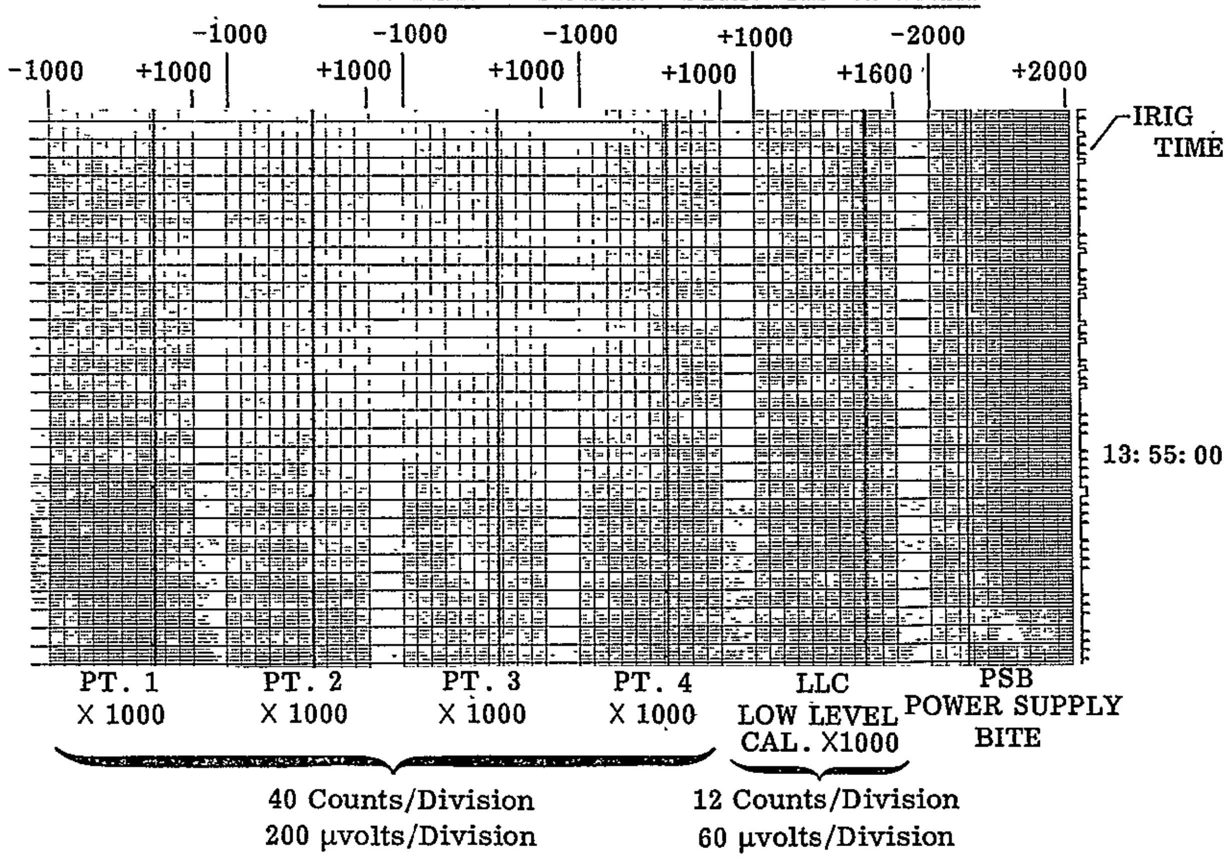
3a. Real Time TM Data and ground station hard copy data for PT. 1→PT.4

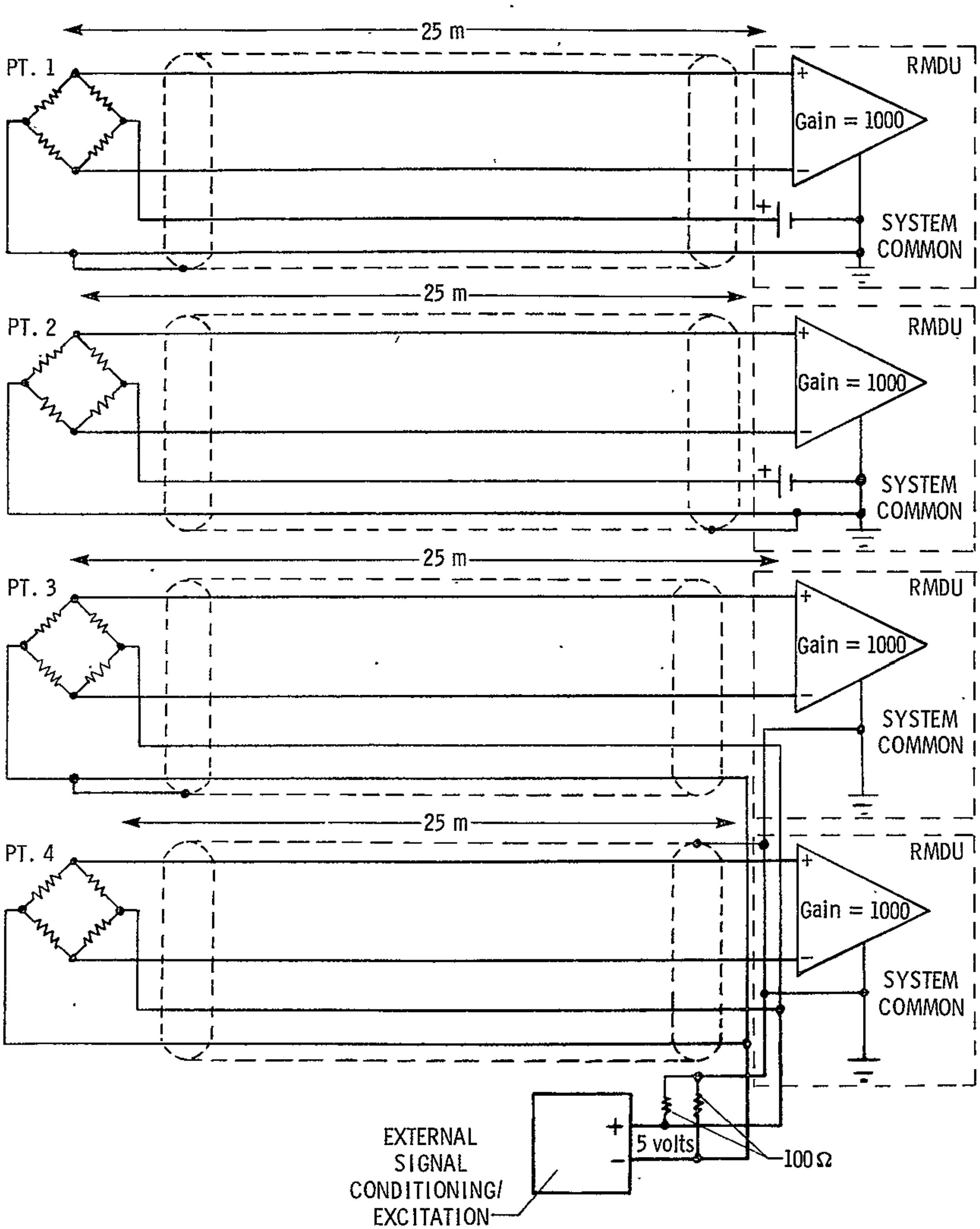
APPENDIX 3a

GROUND STATION HARD COPY DATA OUTPUT

IRIG-B TIME TRACK	AMX 1-1 X 1000 PT. 1	AMX 1-2 X 1000 PT. 2	AMX 1-3 X 1000 PT. 3	AMX 1-4 X 1000 PT. 4
13:55:01:222	420.	202.	340.	242.
13:55:01:227	420.	202.	340.	242.
13:55:01:232	420.	202.	340.	242.
13:55:01:237	420.	202.	340.	242.
13:55:01:242	425.	197,	335.	244.
13:55:01:247	425.	197.	335.	244.
13:55:01:252	425.	197.	335.	244.
13:55:01:257	425.	197.	335.	244.
13:55:01:262	419.	197.	328.	228.
13:55:01:267	419.	197.	326.	228.
13:55:01:272	419.	197.	328.	228.
13:55:01:277	419.	197.	328.	228.
13:55:01:282	427.	202.	339.	236.
13:55:01:287	427.	202.	339.	236.
13:55:01:292	427.	202.	339.	236.
13:55:01:297	427.	202.	339.	236.
13:55:01:302	421.	197.	337.	247.
13:55:01:307	421.	197.	337.	247.
13:55:01:312	421.	197.	337.	247.
13:55:01:317	421.	197.	337.	247.
13:55:01.322	417.	196.	329.	234.
13:55:01:327	417.	196.	329.	234.
13:55:01.332	417.	196.	329.	234.
13:55:01:342	424.	202.	320.	246.
13:55:01:347	424.	202.	320.	246.
13:55:01:352	424.	202.	320.	246.
13:55:01:357	424.	202.	320.	246.
13:55:01:362	423.	204.	331.	238.
13:55:01:367	423.	204.	331.	238.

REAL TIME TELEMETRY STRIP CHART DATA



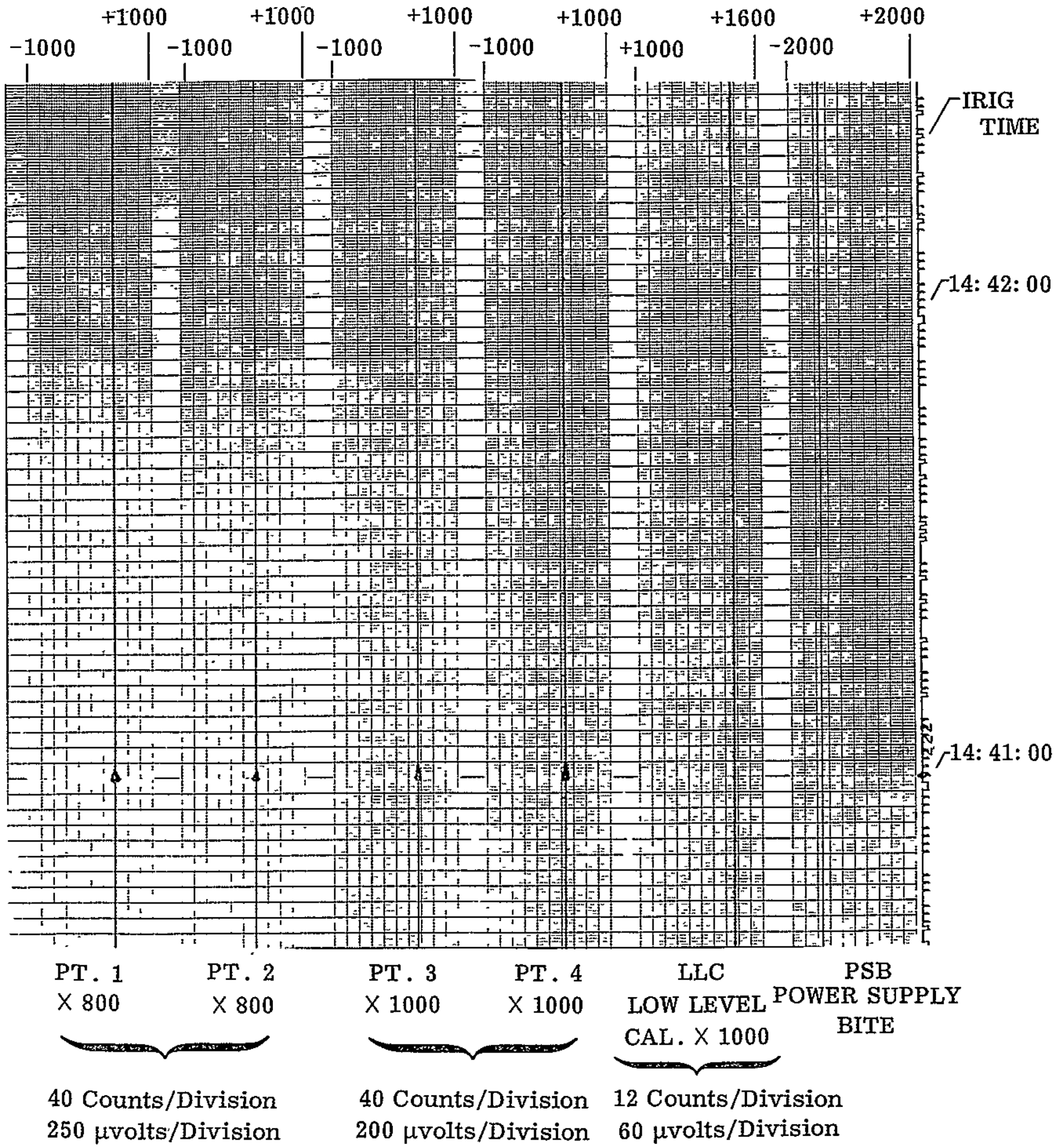


SHIELDING AND EXCITATION CONFIGURATION FOR PT. 1→PT. 4

APPENDIX 3b

3b. Real Time TM Data and ground station hard copy data for PT. 1→PT. 4

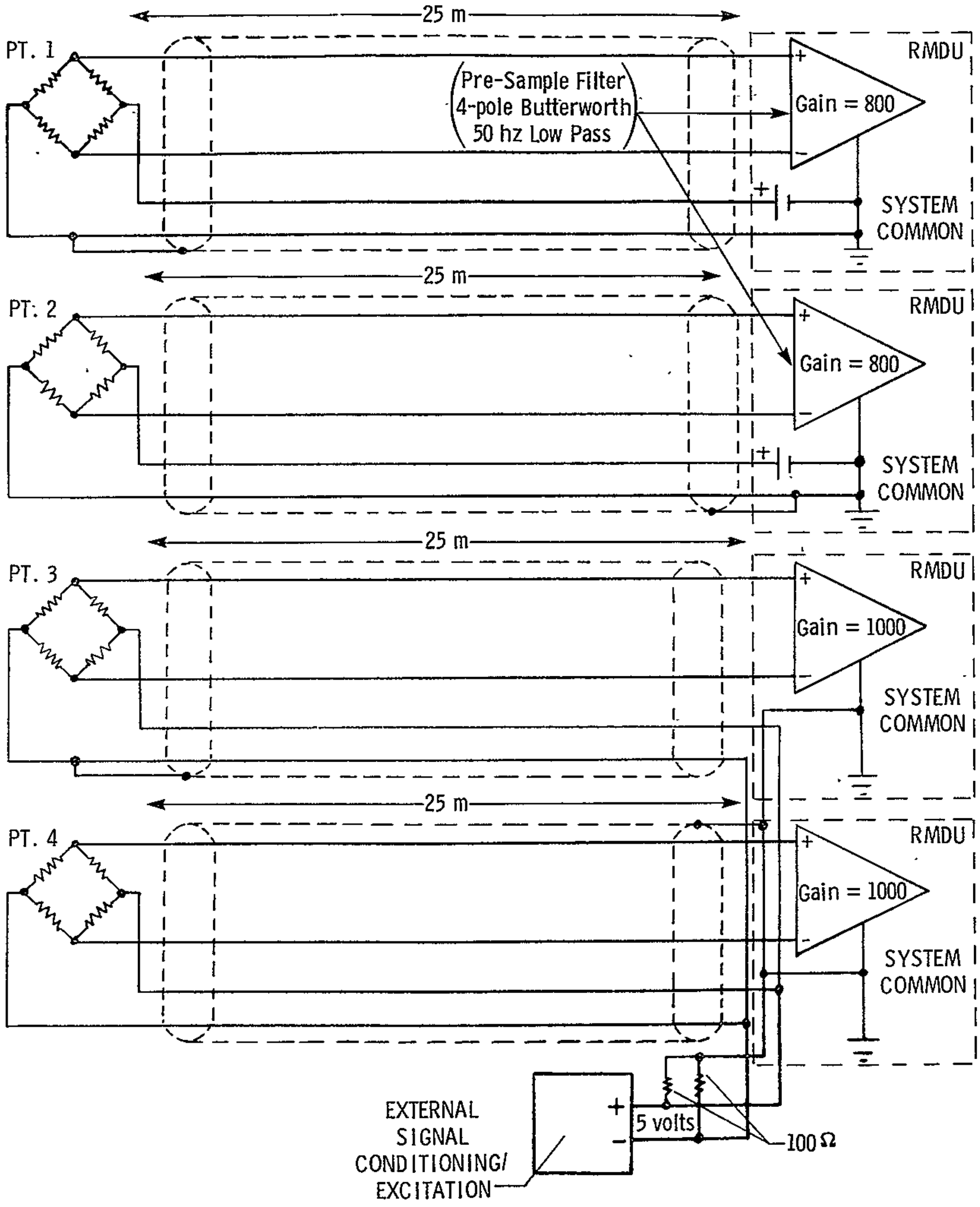
REAL TIME TELEMETRY STRIP CHART DATA



LISTING START TIME: 00:00:00:000 LISTING END TIME: 23:23:23:000

JETSTAR FLT 479 AIFTDS SYSTEM COUNTS

IRIG-B TIME TRACK	PT. 1 CH 81 A1X800	PT. 2 CH 82 A2X800	PT. 3 CH 83 A3X1000	PT. 4 CH 84 A4X1000
14:41:00:067	195.	376.	345.	250.
14:41:00:072	195.	376.	339.	252.
14:41:00:082	195.	376.	339.	252.
14:41:00:087	195.	376.	339.	252.
14:41:00:092	195.	376.	339.	252.
14:41:00:097	195.	376.	341.	253.
14:41:00:102	195.	376.	341.	253.
14:41:00:107	195.	376.	341.	253.
14:41:00:112	195.	376.	341.	253.
14:41:00:117	195.	377.	344.	250.
14:41:00:122	195.	377.	344.	250.
14:41:00:127	195.	377.	344.	250.
14:41:00:132	195.	377.	344.	250.
14:41:00:137	195.	376.	344.	252.
14:41:00:142	195.	376.	344.	252.
14:41:00:147	195.	376.	344.	252.
14:41:00:152	195.	376.	344.	252.
14:41:00:157	195.	376.	343	244.
14:41:00:162	195.	376.	343.	244.
14:41:00:167	195.	376.	343.	244.
14:41:00:172	195.	376.	343.	244.
14:41:00:177	195.	376.	345.	247.
14:41:00:182	195.	376.	345.	247.
14:41:00:187	195.	376.	345.	247.
14:41:00:192	195.	376.	345.	247.
14:41:00:197	196.	376.	339.	252.
14:41:00:202	195	376.	339.	252.
14:41:00:207	196.	376.	339.	252.
14:41:00:212	196.	376.	339.	252.
14:41:00:217	195.	376.	342.	248.
14:41:00:222	195.	376.	342.	248.
14:41:00:227	195.	376	342.	248.
14:41:00:232	195.	376.	342.	248.
14:41:00:237	195.	376.	344.	256.
14:41:00:242	195.	376.	344.	256.
14:41:00:247	195.	376.	344.	256.
14:41:00:252	195.	376.	344.	256.
14:41:00:257	195.	376.	344.	257.
14:41:00:262	195.	376.	344.	257.
14:41:00:267	196.	376.	344.	257.
14:41:00:277	195.	377.	345.	249.
14:41:00:282	195.	377.	345.	249.
14:41:00:287	195.	377.	345.	249.
14:41:00:292	195.	377.	345.	249.
14:41:00:297	195.	377.	344.	256.
14:41:00:302	195.	377.	344.	256.
14:41:00:307	195.	377.	344.	256.
14:41:00:312	195.	377	344.	256.
14:41:00:317	195.	376	340.	236.
14:41:00:322	195.	376.	340.	236.



SHIELDING AND EXCITATION CONFIGURATION FOR PT. 1→PT. 4

PT.1 AND PT.2 (From Flight 439 - Unfiltered Gain = 1000)

PT.1 Gain = 1000 Unfiltered

Median value	=	374.00 Counts
Mean value $\overline{X}$	=	374.44 Counts
Maximum value	=	383.00 Counts
Minimum value	=	367.00 Counts
RMS deviation σ	=	2.89 Counts

PT.2 Gain = 1000 Unfiltered

Median value	=	158.00 Counts
Mean value $\overline{X}$	=	163.74 Counts
Maximum value	=	256.00 Counts
Minimum value	=	85.00 Counts
RMS deviation σ	=	54.32 Counts

PT.1 AND PT.2 GAIN = 800 FILTERED (From Flight #479)

PT.1 Gain = 800 Filtered

Median value	=	376.00 Counts
Mean value $\overline{X}$	=	376.33 Counts
Maximum value	=	377.00 Counts
Minimum value	=	376.00 Counts
RMS deviation	=	0.47 Counts

PT.2 Gain = 800 Filtered

Median value	=	195.00 Counts
Mean value $\overline{X}$	=	195.04 Counts
Maximum value	=	196.00 Counts
Minimum value	=	195.00 Counts
RMS deviation σ	=	0.20 Counts

APPENDIX 3c

3c. Internal precision voltage response for gains of 400 and 1000

PRECISION VOLTAGE CHANNELS: (From Flight #481)

Low Level Calibration (7.3237 mv) at Gain = 1000:

Median value	=	1458.00 Counts
Mean value $\overline{X}$	=	1457.89 Counts
Maximum value	=	1460.00 Counts
Minimum value	=	1454.00 Counts
RMS deviation σ	=	1.15 Counts

Shorted Channel Response at Gain = 400:

Median value	=	2.00 Counts
Mean value $\overline{X}$	=	1.99 Counts
Maximum value	=	8.00 Counts
Minimum value	=	0.00 Counts
RMS diviation σ	=	1.08 Counts

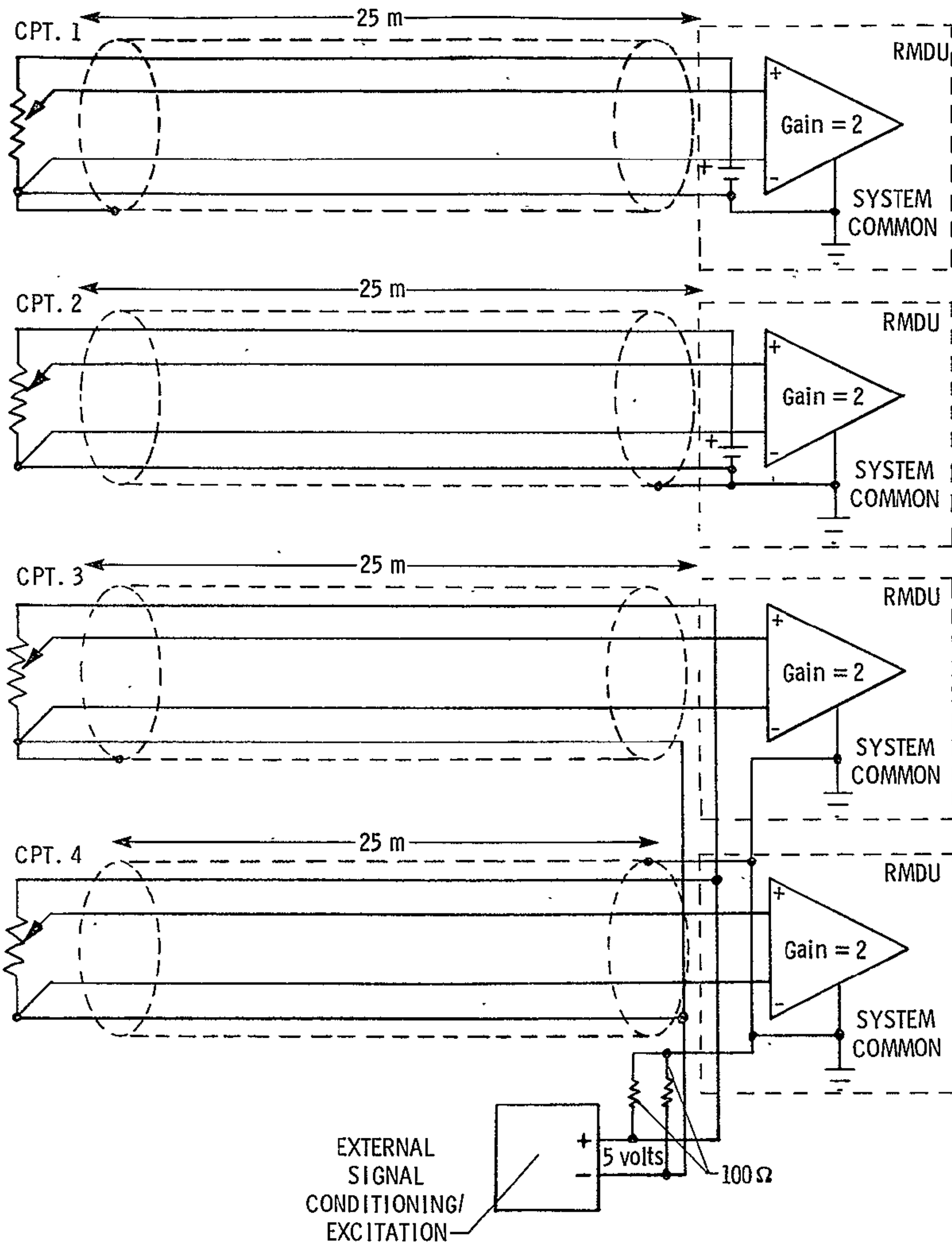
Gain Programmable Amplifier's Zero Response (GPA-Ø) at Gain = 400:

Median value	=	4.00 Counts
Mean value	=	3.90 Counts
Maximum value	=	6.00 Counts
Minimum value	=	1.00 Counts
RMS deviation σ	=	0.62 Counts

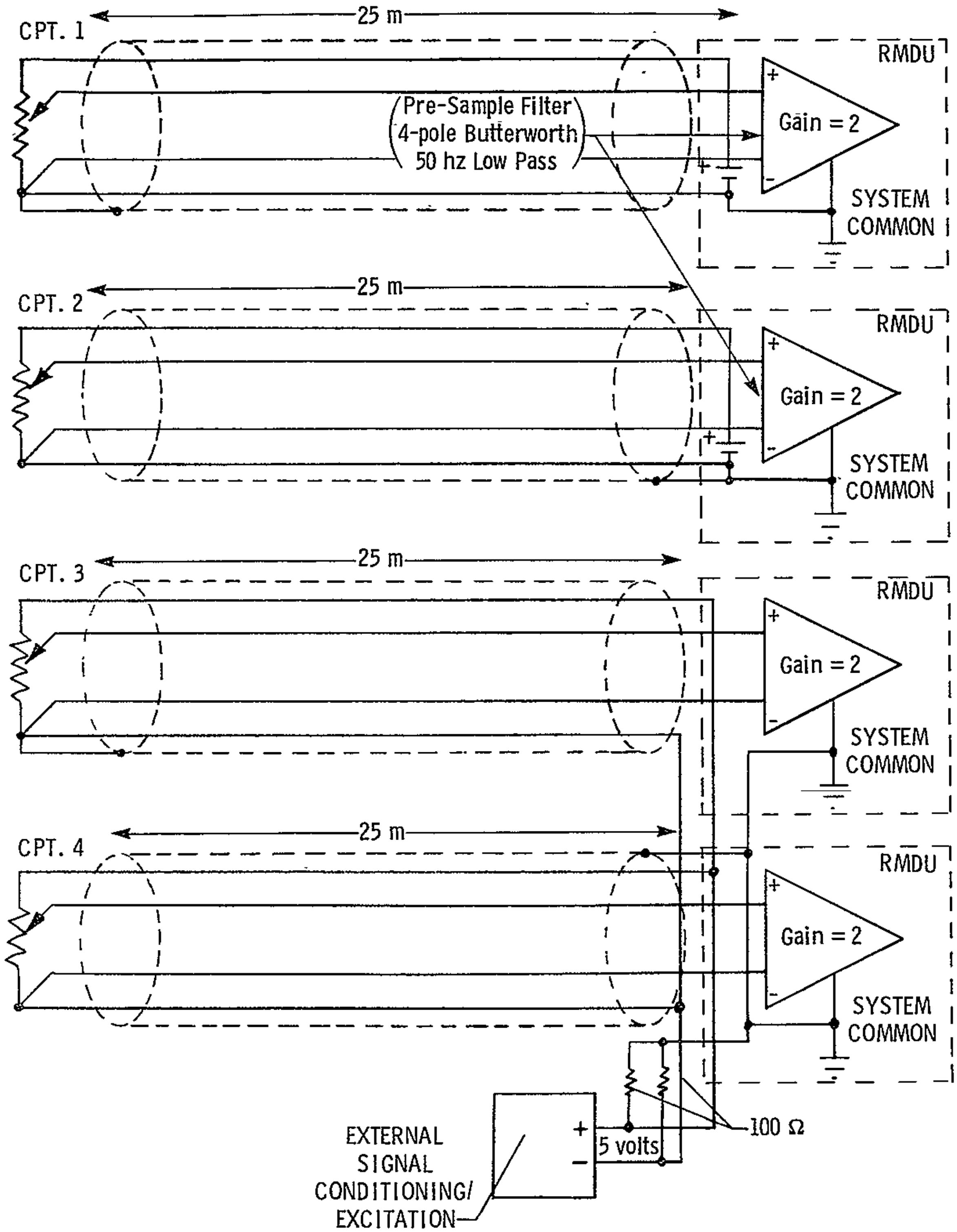
NOTE: For Gains of 1000 each Count = 5μ volts
For Gains of 400 each Count = 12μ volts

APPENDIX 3d

3d. Strip chart and ground station hard copy data for CPT1→CPT4 showing shielding, excitation, and pre-sample filter response.



SHIELDING AND EXCITATION FOR CPT. 1→CPT. 4; FLIGHT #439

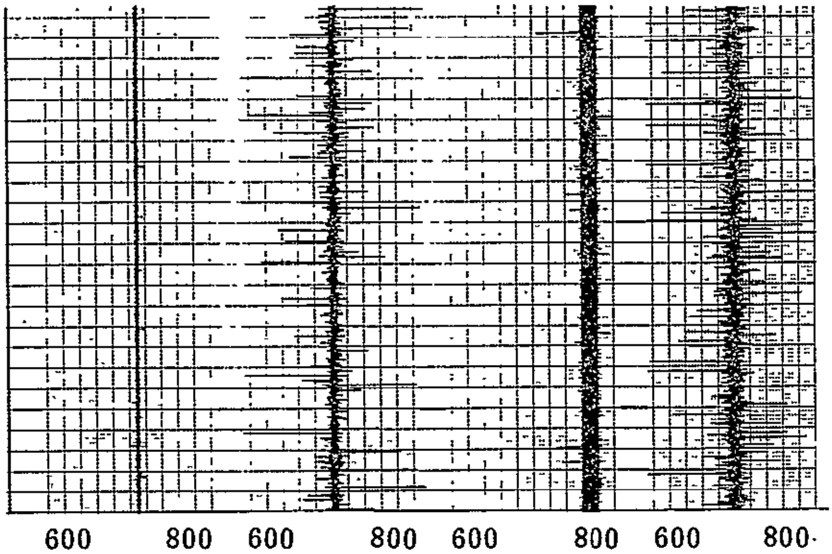


SHIELDING AND EXCITATION - FILTERING FOR CPT. 1→CPT. 4; FLIGHT #479

REAL TIME STRIP CHART TELEMETRY DATA FOR CPT. 1 ⟶ CPT. 4: FILTERED vs. UNFILTERED

FLIGHT # 439

CPT. 1 X 2 UNFILTERED | CPT. 2 X 2 UNFILTERED | CPT. 3 X 2 UNFILTERED | CPT. 4 X 2 UNFILTERED

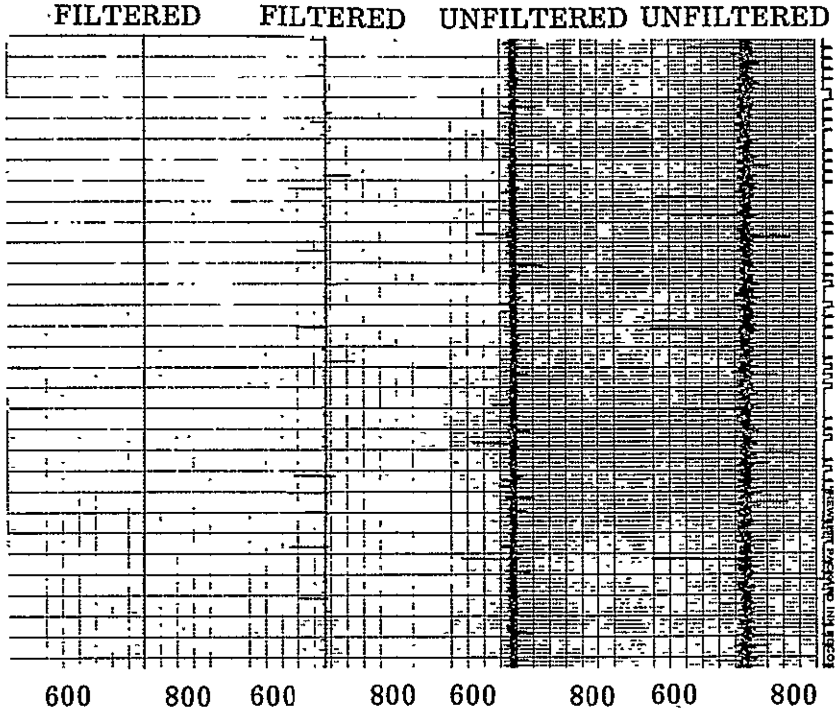


IRIG TIME
10: 54: 00

Note: For gain = 2 each division represents 4 counts or 10 mvolts.

FLIGHT # 479

CPT. 1 X 2 FILTERED | CPT. 2 X 2 FILTERED | CPT. 3 X 2 UNFILTERED | CPT. 4 X 2 UNFILTERED



IRIG TIME
14: 32: 00

LISTING START TIME: 00:00:00:000 LISTING END TIME: 23:23:23:000

JETSTAR FLT 4 9 AIFTDS SYSTEM COUNTS

TIME	CH131 A22X2	CH141 A23X2	CH132 A24X2	CH142 A25X2	CH133 A22X1	CH143 A23X1	CH134 A24X1	CH144 A25X1	CH103 A12X10	CH104 A13X10
10:54:00:413	710.	711.	780.	696.	356.	348.	390.	340.	1.	1.
10:54:00:418	710.	711.	780.	696.	356.	348.	390.	340.	1.	1.
10:54:00:423	710.	711.	780.	696.	356.	348.	390.	340.	1.	1.
10:54:00:428	710.	711.	772.	696.	354.	348.	385.	340.	1.	1.
10:54:00:433	710.	711.	772.	696.	354.	348.	385.	340.	1.	0.
10:54:00:438	710.	711.	772.	696.	354.	348.	385.	340.	1.	0.
10:54:00:443	710.	711.	772.	696.	354.	348.	385.	340.	1.	0.
10:54:00:448	710.	699.	772.	710.	354.	356.	385.	359.	1.	0.
10:54:00:453	710.	699.	772.	710.	354.	356.	385.	359.	1.	0.
10:54:00:458	710.	699.	772.	710.	354.	356.	385.	359.	1.	0.
10:54:00:463	710.	699.	772.	710.	354.	356.	385.	359.	1.	0.
10:54:00:468	712.	699.	764.	710.	354.	356.	387.	359.	1.	0.
10:54:00:473	712.	699.	764.	710.	354.	356.	387.	359.	1.	1.
10:54:00:478	712.	699.	764.	710.	354.	356.	387.	359.	1.	1.
10:54:00:483	712.	699.	764.	710.	354.	356.	387.	359.	1.	1.
10:54:00:488	712.	705.	764.	705.	354.	355.	387.	353.	1.	1.
10:54:00:493	712.	705.	764.	705.	354.	355.	387.	353.	1.	0.
10:54:00:498	712.	705.	764.	705.	354.	355.	387.	353.	1.	0.
10:54:00:503	712.	705.	764.	705.	354.	355.	387.	353.	1.	0.
10:54:00:508	712.	705.	775.	705.	354.	355.	392.	353.	1.	0.
10:54:00:513	712.	705.	775.	705.	354.	355.	392.	353.	1.	0.
10:54:00:518	712.	705.	775.	705.	354.	355.	392.	353.	1.	0.
10:54:00:523	712.	705.	775.	705.	354.	355.	392.	353.	1.	0.
10:54:00:528	712.	710.	775.	704.	354	353.	392.	335.	1.	0.
10:54:00:533	712.	710.	775.	704.	354.	353.	392.	335.	1.	0.
10:54:00:538	712.	710.	775.	704.	354.	353.	392.	335.	1.	0.
10:54:00:543	712.	710.	775.	704.	354.	353.	392.	335.	1.	0.
10:54:00:548	713.	710.	769.	704.	356.	353.	382.	335.	1.	0.
10:54:00:553	713.	710.	769.	704.	356.	353.	382.	335.	1.	1.
10:54:00:558	713.	710.	769.	704.	356.	353.	382.	335.	1.	1.
10:54:00:563	713.	710.	769.	704.	356.	353.	382	335.	1.	1.
10:54:00:568	713.	700.	769.	698.	356.	353.	382.	351.	1.	1.
10:54:00:573	713.	700.	769.	698.	356.	353.	382.	351.	1.	0.
10:54:00:578	713.	700.	769.	698.	356.	353.	382.	351.	1.	0.
10:54:00:583	713.	700.	769.	698.	356.	353.	382.	351.	1.	0.
10:54:00:588	712.	700.	770.	698.	354.	353.	387.	351.	1.	0.
10:54:00:593	712.	700.	770.	698.	354.	353.	387.	351.	1.	0.
10:54:00:598	712.	700.	770.	698.	354.	353.	387.	351.	1.	0.
10:54:00:603	712.	700.	770.	698.	354.	353.	387.	351.	1.	0.
10:54:00:608	712.	705.	770.	705.	354.	356.	387.	348.	1.	0.
10:54:00:613	712.	705.	770.	705.	354.	356.	387.	348.	0.	0.
10:54:00:618	712.	705.	770.	705.	354.	356.	387.	348.	0.	0.
10:54:00:623	712.	705.	770.	705.	354.	356.	387.	348.	0.	0.
10:54:00:628	709.	705.	775.	705.	354.	356.	392.	348.	0.	0.
10:54:00:633	709.	705.	775.	705.	354.	356.	392.	348.	1.	0.
10:54:00:638	709.	705.	775.	705.	354.	356.	392.	348.	1.	0.
10:54:00:643	709.	705.	775.	705.	354.	356.	392.	348.	1.	0.
10:54:00:648	709.	701.	775.	705.	354.	352.	392.	354.	1.	0.
10:54:00:653	709.	701.	775.	705.	354.	352.	392.	354.	1.	0.
10:54:00:658	709.	701.	775.	705.	354.	352.	392.	354.	1.	0.
	CPT. 1 X 2	CPT. 2 X 2	CPT. 3 X 2	CPT. 4 X 2	CPT. 1 X 1	CPT. 2 X 1	CPT. 3 X 1	CPT. 4 X 1	SHORTED CHANNEL X 1	SHORTED CHANNEL X 1

LISTING START TIME: 00:00:00:000. LISTING END TIME: 23:23:23:000

JETSTAR FLT 439 AIFTDS SYSTEM COUNTS

TIME	CH131 A22X2	CH141 A23X2	CH132 A24X2	CH142 A25X2	CH123 A22X1	CH143 A23X1	CH134 A24X1	CH144 A25X1	CH103 A12X10	CH104 A13X10
10:54:00:163	711.	700.	774.	687.	355.	352.	383.	349.	1.	1.
10:54:00:168	711.	702.	774.	700.	355.	350.	383.	355.	1.	1.
10:54:00:173	711.	702.	774.	700.	355.	350.	383.	355.	1.	1.
10:54:00:178	711.	702.	774.	700.	355.	350.	383.	355.	1.	1.
10:54:00:183	711.	702.	774.	700.	355.	350.	383.	355.	1.	1.
10:54:00:188	711.	702.	781.	700.	354.	350.	390.	355.	1.	1.
10:54:00:193	711.	702.	781.	700.	354.	350.	390.	355.	1.	0.
10:54:00:198	711.	702.	781.	700.	354.	350.	390.	355.	1.	0.
10:54:00:203	711.	702.	781.	700.	354.	350.	390.	355.	1.	0.
10:54:00:208	711.	708.	781.	702.	354.	353.	390.	353.	1.	0.
10:54:00:213	711.	708.	781.	702.	354.	353.	390.	353.	1.	0.
10:54:00:218	711.	708.	781.	702.	354.	353.	390.	353.	1.	0.
10:54:00:223	711.	708.	781.	702.	354.	353.	390.	353.	1.	0.
10:54:00:228	714.	708.	762.	702.	354.	353.	382.	353.	1.	0.
10:54:00:233	714.	708.	762.	702.	354.	353.	382.	353.	1.	1.
10:54:00:238	714.	708.	762.	702.	354.	353.	382.	353.	1.	1.
10:54:00:243	714.	708.	762.	702.	354.	353.	382.	353.	1.	1.
10:54:00:248	714.	708.	762.	712.	354.	348.	382.	108.	1.	1.
10:54:00:253	714.	708.	762.	712.	354.	348.	382.	108.	1.	1.
10:54:00:258	714.	708.	762.	712.	354.	348.	382.	108.	1.	1.
10:54:00:263	714.	708.	762.	712.	354.	348.	382.	108.	1.	1.
10:54:00:268	712.	708.	780.	712.	353.	348.	388.	108.	1.	1.
10:54:00:273	712.	708.	780.	712.	353.	348.	388.	108.	1.	0.
10:54:00:278	712.	708.	780.	712.	353.	348.	388.	108.	1.	0.
10:54:00:283	712.	708.	780.	712.	353.	348.	388.	108.	1.	0.
10:54:00:288	712.	705.	780.	677.	353.	355.	388.	365.	1.	0.
10:54:00:293	712.	705.	780.	677.	353.	355.	388.	365.	1.	1.
10:54:00:298	712.	705.	780.	677.	353.	355.	388.	365.	1.	1.
10:54:00:303	712.	705.	780.	677.	353.	355.	388.	365.	1.	1.
10:54:00:308	710.	705.	774.	677.	352.	355.	389.	365.	1.	1.
10:54:00:313	710.	705.	774.	677.	353.	355.	389.	365.	1.	0.
10:54:00:318	710.	705.	774.	677.	353.	355.	389.	365.	1.	0.
10:54:00:323	710.	705.	774.	677.	353.	355.	389.	355.	1.	0.
10:54:00:328	710.	706.	774.	690.	353.	354.	389.	359.	1.	0.
10:54:00:333	710.	706.	774.	690.	353.	354.	389.	359.	1.	0.
10:54:00:338	710.	706.	774.	690.	353.	354.	389.	359.	1.	0.
10:54:00:343	710.	706.	774.	690.	353.	354.	389.	359.	1.	0.
10:54:00:348	712.	706.	784.	690.	354.	354.	383.	359.	1.	0.
10:54:00:353	712.	706.	784.	690.	354.	354.	383.	359.	1.	1.
10:54:00:358	712.	706.	784.	690.	354.	354.	383.	359.	1.	1.
10:54:00:363	712.	706.	784.	690.	354.	354.	383.	359.	1.	1.
10:54:00:368	712.	706.	784.	706.	354.	352.	383.	355.	1.	1.
10:54:00:373	712.	706.	784.	706.	354.	352.	383.	355.	1.	0.
10:54:00:378	712.	706.	784.	706.	354.	352.	383.	355.	1.	0.
10:54:00:383	712.	706.	784.	706.	354.	352.	383.	355.	1.	0.
10:54:00:388	710.	706.	780.	706.	356.	352.	390.	355.	1.	0.
10:54:00:393	710.	706.	780.	706.	356.	352.	390.	355.	1.	0.
10:54:00:398	710.	706.	780.	706.	356.	352.	390.	355.	1.	0.
10:54:00:403	710.	706.	780.	706.	356.	352.	390.	355.	1.	0.
10:54:00:408	710.	711.	780.	696.	356.	348.	390.	340.	1.	0.
	CPT. 1 X 1	CPT. 2 X 1	CPT. 3 X 1	CPT. 4 X 1	CPT. 1 X 2	CPT. 2 X 2	CPT. 3 X 2	CPT. 4 X 2	SHORTED CHANNEL X 1	SHORTED CHANNEL X 1

LISTING START TIME: 00:00:00:000 LISTING END TIME: 23:23:23:000

JETSTAR FLT 479 AIFTDS SYSTEM COUNTS

TIME	CH131 A22X2	CH141 A23X2	CH132 A24X2	CH142 A25X2	CH133 A22X1	CH143 A23X1	CH134 A24X1	CH144 A25X1	CH103 A12X10	CH104 A13X10
14:32:00:842	716.	692.	674.	720.	357.	346.	336.	369.	- 1.	- 1.
14:32:00:847	716.	692.	674.	720.	357.	346.	336.	369.	- 1.	- 1.
14:32:00:852	716.	692.	674.	720.	357.	346.	336.	369.	- 1.	- 1.
14:32:00:857	716.	692.	672.	720.	357.	346.	337.	369.	- 1.	- 1.
14:32:00:862	716.	692.	672.	720.	357.	346.	337.	369.	- 1.	- 1.
14:32:00:867	716.	692.	672.	720.	357.	346.	337.	369.	- 1.	- 1.
14:32:00:872	716.	692.	672.	720.	357.	346.	337.	369.	- 1.	- 1.
14:32:00:877	716.	692.	672.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:882	716.	692.	672.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:887	716.	692.	672.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:892	716.	692.	672.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:897	716.	692.	676.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:402	716.	692.	676.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:407	716.	692.	676.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:412	716.	692.	676.	715.	357.	346.	337.	353.	- 1.	- 1.
14:32:00:417	716.	692.	676.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:422	716.	692.	676.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:427	716.	692.	676.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:432	716.	692.	676.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:437	716.	692.	671.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:442	716.	692.	671.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:447	716.	692.	671.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:452	716.	692.	671.	714.	357.	346.	337.	357.	- 1.	- 1.
14:32:00:457	716.	693.	671.	716.	357.	347.	337.	356.	- 1.	- 1.
14:32:00:462	716.	693.	671.	716.	357.	347.	337.	356.	- 1.	- 1.
14:32:00:467	716.	693.	671.	716.	357.	347.	337.	356.	- 1.	- 1.
14:32:00:472	716.	693.	671.	716.	357.	347.	337.	356.	- 1.	- 1.
14:32:00:477	716.	693.	674.	716.	357.	347.	340.	356.	- 1.	- 1.
14:32:00:482	716.	693.	674.	716.	357.	347.	340.	356.	- 1.	- 1.
14:32:00:487	716.	693.	674.	716.	357.	347.	340.	356.	- 1.	- 1.
14:32:00:492	716.	693.	674.	716.	357.	347.	340.	356.	- 1.	- 1.
14:32:00:497	716.	692.	674.	709.	357.	346.	340.	353.	- 1.	- 1.
14:32:00:502	716.	692.	674.	709.	357.	346.	340.	353.	- 1.	- 1.
14:32:00:507	716.	692.	674.	709.	357.	346.	340.	353.	- 1.	- 1.
14:32:00:512	716.	692.	674.	709.	357.	346.	340.	353.	- 1.	- 1.
14:32:00:517	716.	692.	675.	709.	357.	346.	340.	353.	- 1.	- 1.
14:32:00:522	716.	692.	675.	709.	357.	346.	340.	353.	- 1.	- 1.
14:32:00:527	716.	692.	675.	709.	357.	345.	340.	353.	- 1.	- 1.
14:32:00:532	716.	692.	675.	709.	357	346.	340.	353.	- 1.	- 1.
14:32:00:537	716.	693.	675.	715.	357.	347.	340.	358.	- 1.	- 1.
14:32:00:542	716.	693.	675.	715.	357.	347.	340.	358.	- 1.	- 1.
14:32:00:547	716.	693.	675.	713.	357.	347.	340.	350.	- 1.	- 1.
14:32:00:552	716.	693.	675.	715.	357	347.	340.	358.	- 1.	- 1.
14:32:00:557	716.	693.	673.	715.	357.	347.	341.	358.	- 1.	- 1.
14:32:00:562	716.	693.	673.	715.	357.	347.	341.	358.	- 1.	- 1.
14:32:00:567	716.	693.	673.	715.	357.	347.	341.	358.	- 1.	- 1.
14:32:00:572	716.	693.	673.	715.	357.	347.	341.	358.	- 1.	- 1.
14:32:00:577	716.	692.	673.	716.	357.	347.	341.	361.	- 1.	- 1.
14:32:00:582	716.	692.	673.	716.	357.	347.	341.	361.	- 1.	- 1.
14:32:00:587	716.	692.	673.	716.	357.	347.	341.	361.	- 1.	- 1.
	CPT. 1 X 2 FILTERED	CPT. 2 X 2 FILTERED	CPT. 3 X 2	CPT. 4 X 2	CPT. 1 X 1 FILTERED	CPT. 2 X 1 FILTERED	CPT. 3 X 1	CPT. 4 X 1	SHORTED CHANNEL X 1	SHORTED CHANNEL X 1

12/29/77 14:57:32 P0HC SYSTEMS'REAL-TIME MONITOR-5.2 PAGE 5

LISTING START TIME: 00:00:00:000 LISTING END TIME: 23:23:23:000

JETSTAR FLT 479 AIFTDS SYSTEM COUNTS

TIME	CH131 A22X2	CH141 A23X2	CH132 A24X2	CH142 A25X2	CH133 A22X1	CH143 A23X1	CH134 A24X1	CH144 A25X1		CH103 A12X10		CH104 A13X10
14:32:00:692	716.	692.	673.	716.	357.	347.	341.	361.	-	1.	-	1.
14:32:00:597	716.	692.	672.	716.	357.	347.	338.	361.	-	1.	-	1.
14:32:00:602	716.	692.	672.	716.	357.	347.	338.	361.	-	1.	-	1.
14:32:00:607	716.	692.	672.	716.	357.	347.	338.	361.	-	1.	-	1.
14:32:00:612	716.	692.	672.	716.	357.	347.	338.	361.	-	1.	-	1.
14:32:00:617	716.	692.	672.	714.	357.	347.	338.	362.	-	1.	-	1.
14:32:00:622	716.	692.	672.	714.	357.	347.	338.	362.	-	1.	-	1.
14:32:00:627	716.	692.	672.	714.	357.	347.	338.	362.	-	1.	-	1.
14:32:00:632	716.	692.	672.	714.	357.	347.	338.	362.	-	1.	-	1.
14:32:00:637	716.	692.	672.	714.	357.	347.	339.	362.	-	1.	-	1.
14:32:00:642	716.	692.	672.	714.	357.	347.	339.	362.	-	1.	-	1.
14:32:00:647	716.	692.	672.	714.	357.	347.	339.	362.	-	1.	-	1.
14:32:00:652	716.	692.	672.	714.	357.	347.	339.	362.	-	1.	-	1.
14:32:00:657	716.	692.	672.	717.	357.	358.	339.	363.	-	1.	-	1.
14:32:00:662	716.	692.	672.	717.	357.	358.	339.	363.	-	1.	-	1.
14:32:00:667	716.	692.	672.	717.	357.	358.	339.	363.	-	1.	-	1.
14:32:00:672	716.	692.	672.	717.	357.	358.	339.	363.	-	1.	-	1.
14:32:00:677	716.	692.	672.	717.	357.	358.	343.	363.	-	1.	-	1.
14:32:00:682	716.	692.	672.	717.	357.	358.	343.	363.	-	1.	-	1.
14:32:00:687	716.	692.	672.	717.	357.	358.	343.	363.	-	1.	-	1.
14:32:00:692	716.	692.	672.	717.	357.	358.	343.	363.	-	1.	-	1.
14:32:00:697	716.	692.	672.	713.	357.	346.	343.	356.	-	1.	-	1.
14:32:00:702	716.	692.	672.	713.	357.	346.	343.	356.	-	1.	-	1.
14:32:00:707	716.	692.	672.	713.	357.	346.	343.	356.	-	1.	-	1.
14:32:00:712	716.	692.	672.	713.	357.	346.	343.	356.	-	1.	-	1.
14:32:00:717	716.	692.	676.	713.	357.	346.	339.	356.	-	1.	-	1.
14:32:00:722	716.	692.	676.	713.	357.	346.	339.	356.	-	1.	-	1.
14:32:00:727	716.	692.	676.	713.	357.	346.	339.	356.	-	1.	-	1.
14:32:00:732	716.	692.	676.	713.	357.	345.	339.	356.	-	1.	-	1.
14:32:00:737	716.	694.	676.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:742	716.	694.	676.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:747	716.	694.	676.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:752	716.	694.	676.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:757	716.	694.	670.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:762	716.	694.	670.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:767	716.	694.	670.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:772	716.	694.	670.	704.	357.	346.	339.	358.	-	1.	-	1.
14:32:00:777	716.	692.	670.	714.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:782	716.	692.	670.	714.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:787	716.	692.	670.	714.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:792	716.	692.	670.	714.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:797	716.	692.	676.	714.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:802	716.	692.	676.	714.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:807	716.	692.	676.	714.	357	345.	339.	355.	-	1.	-	1.
14:32:00:812	716.	692.	676.	714.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:817	716.	692.	676.	719.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:822	716.	692.	676.	719.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:827	716.	692.	676.	719.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:832	716.	692.	670.	719.	357.	346.	339.	355.	-	1.	-	1.
14:32:00:837	716.	692.	671.	719.	357.	346.	338.	355.	-	1.	-	1.
	CPT. 1 X 2 FILTERED	CPT. 2 X 2 FILTERED	CPT. 3 X 2	CPT. 4 X 2	CPT. 1 X 1 FILTERED	CPT. 2 X 1 FILTERED	CPT. 3 X 1	CPT. 4 X 1		SHORTED CHANNEL X 1		SHORTED CHANNEL X 1

UNFILTERED DATA FROM CPT.1 AND CPT.2 (From Flight #439)

CPT.1 Gain = 2 Unfiltered

Median value	=	712.00 Counts
Mean value $\bar{X}$	=	411.42 Counts
Maximum value	=	714.00 Counts
Minimum value	=	709.00 Counts
RMS deviation σ	=	1.34 Counts

CPT.1 Gain = 2 Unfilitered

Median value	=	705.00 Counts
Mean value	=	705.23 Counts
Maximum value	=	711.00 Counts
Minimum value	=	699.00 Counts
RMS deviation σ	=	3.57 Counts

FILTERED DATA FROM CPT.1 AND CPT.2 (From Flight #479)

CPT.1 Gain = 2 Filtered

Median value	=	716.00 Counts
Mean value	=	716.00 Counts
Maximum value	=	716.00 Counts
Minimum value	=	716.00 Counts
RMS deviation σ	=	0.00 Counts

CPT.2 Gain = 2 Filtered

Median value	=	692.00 Counts
Mean value	=	692.32 Counts
Maximum value	=	694.00 Counts
Minimum value	=	692.00 Counts
RMS deviation σ	=	0.61 Counts

1. Report No. NASA TM-72867	2 Government Accession No	3. Recipient's Catalog No
4 Title and Subtitle AIFTDS STAND-ALONE RMDU FLIGHT TEST REPORT		5. Report Date July 1979 6 Performing Organization Code H-1099
7. Author(s) Douglass O. Wilner		8. Performing Organization Report No.
9 Performing Organization Name and Address NASA Dryden Flight Research Center P.O. Box 273 Edwards, California 93523		10. Work Unit No 992-03-01 11. Contract or Grant No
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		13. Type of Report and Period Covered Technical Memorandum 14. Sponsoring Agency Code
15 Supplementary Notes		

16. Abstract

A stand-alone RMDU (remote multiplexer/digitizer unit) was subjected to a flight test environment. This flight test provided a mechanism for the Measurement Engineering Branch to closely scrutinize the response of the RMDU and its associated instrumentation circuitry during an actual flight test. Various instrumentation and shielding schemes were employed during the flight test with the data analysis presented in this report.

17. Key Words (Suggested by Author(s)) Airborne Integrated Flight Test Data System (AIFTDS) Pulse Code Modulation Data Acquisition Shielding Instrumentation Techniques	18. Distribution Statement Unclassified - Unlimited STAR category: 06		
19 Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21 No. of Pages 63	22. Price* $4.25

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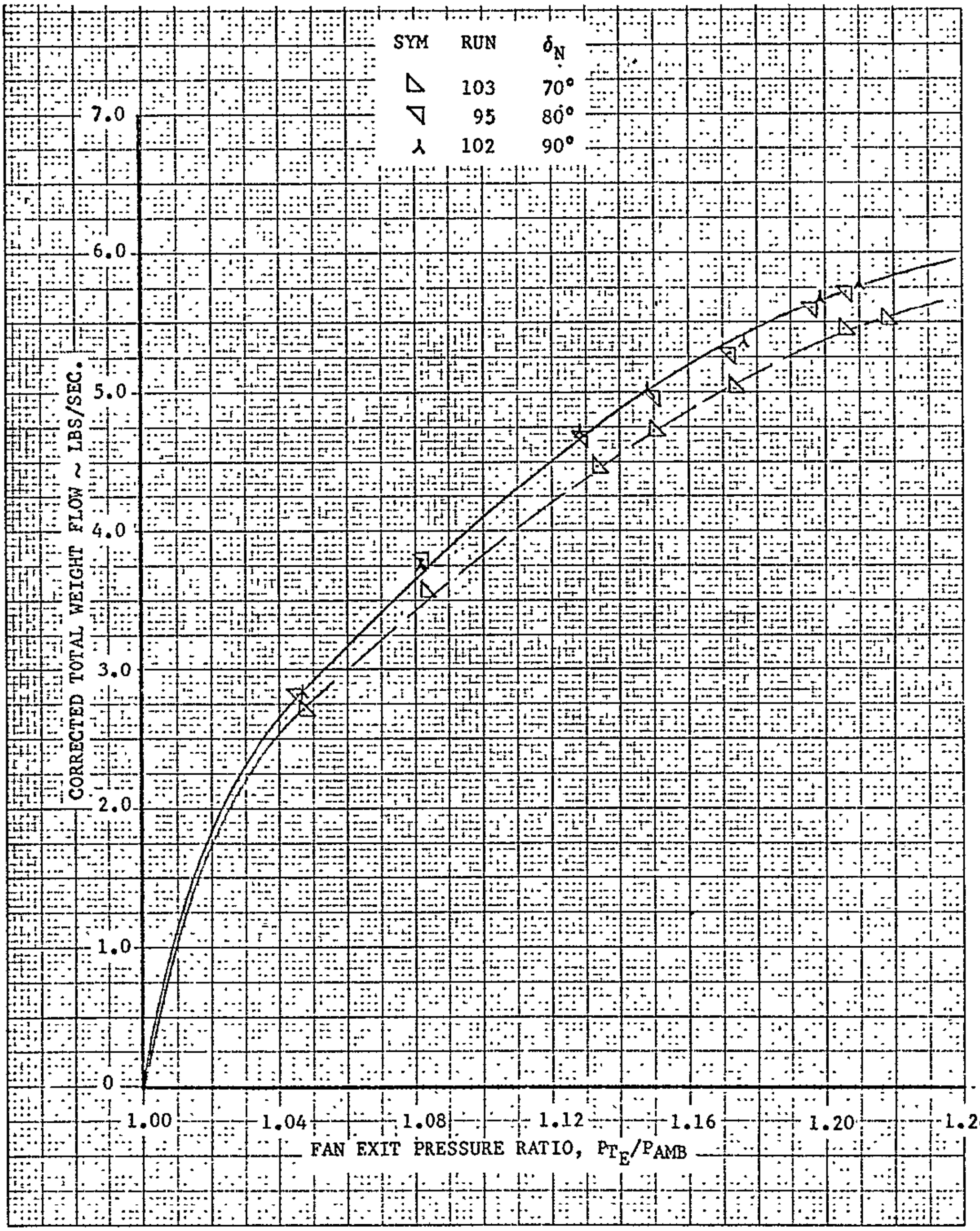

Figure C-6. Fan Calibration, Fan No. 5, Ser. No. 421 (Continued)

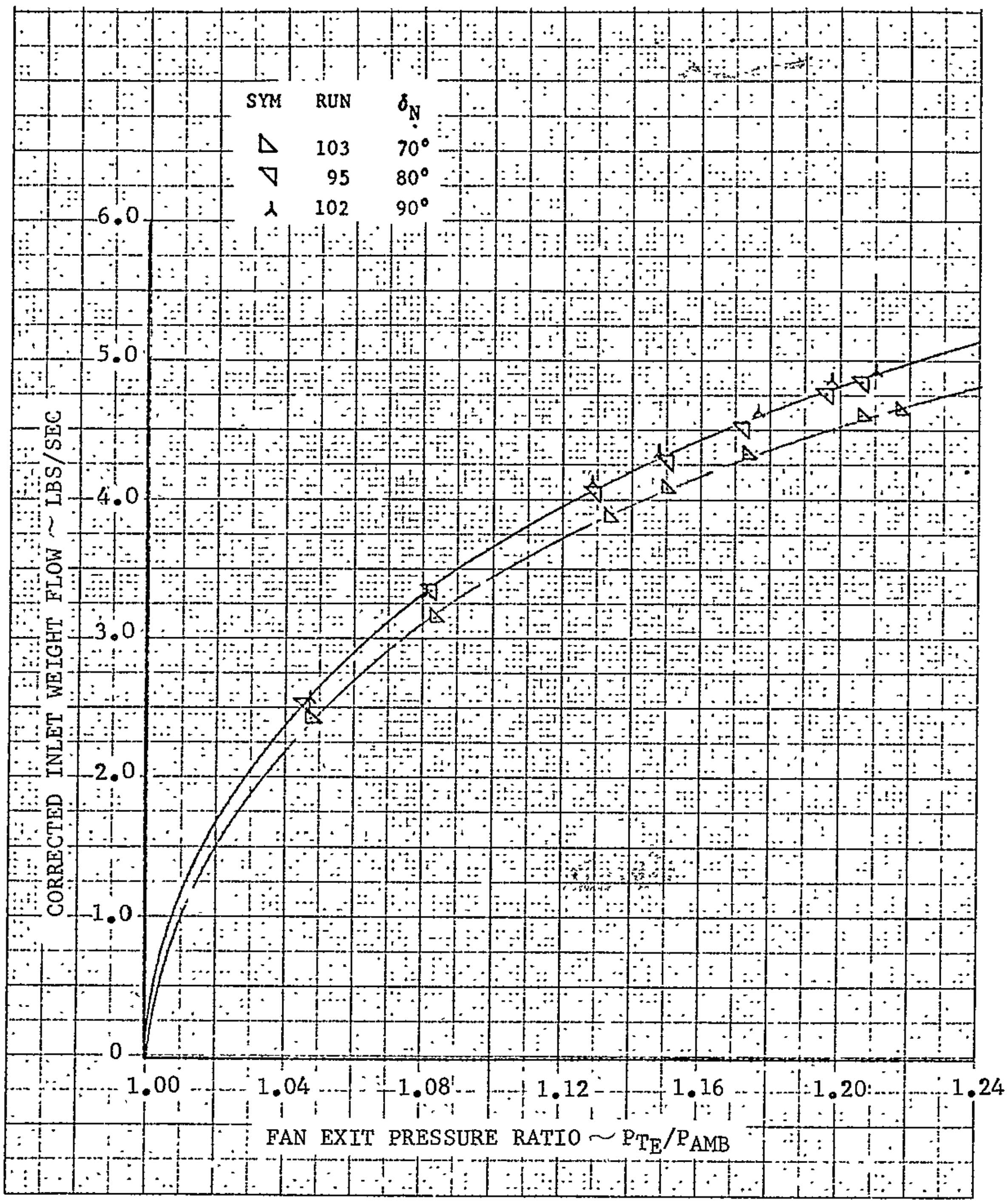

Figure C-6. Fan Calibration, Fan No. 5, Ser. No. 421 (Concluded)